

consulting engineer

Key to Engineering Ethics
Demineralization vs Evaporation
Engineers and Product Development
Rehabilitating a Viaduct
Cybernetics and Engineering
Management Consulting
Liquid Level Control



... The builder's dream is there—

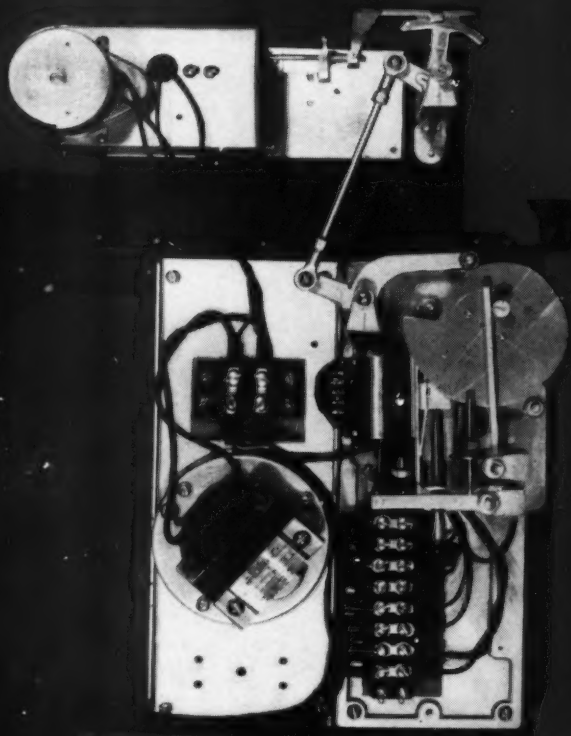
Excellence in Design

DAVID BARNARD STEINMAN had hardly finished hanging out his professional shingle back in 1921 when the chance came for him to design the Florianopolis Bridge in Brazil, first of the distinguished series of bridges which have made him America's best-known bridge engineer. In that

—Continued on page 6

February 1954

a new electronic flow meter!



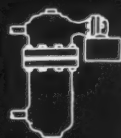
Choice of 3 mercury-less transmitters



Hays Barion
flow or differential
transmitter



Hays
differential
transmitter



Hays liquid
level
transmitter

continuous integration
—no creep at zero

unaffected by normal
voltage, frequency and
temperature changes

electronic operation
provides high speed
and greater accuracy

3 to 1 range calibration
at recorder

HAYS Electronic Flow Meter

Since the circuit is of the electronic null-balance type, it is unaffected by normal voltage and frequency variations. Also, neither temperature variations nor reasonable length of transmission lines affect the calibration of the instrument.

The *pen-drive motor* is built for reversing duty. Normal variations in voltage and frequency have no noticeable effect on its operation.

The *integrator* is continuous in operation and simple in mechanical construction. A micrometer zero adjustment for calibration is easily accessible.

Indicators can be calibrated to read directly in rate-of-flow or other factors as desired.

Write today for full information on the Hays Electronic Flow Meter Bulletin 52-1074-222.

Automatic Combustion Control
Boiler Panels • Hays-Penn Flowmeters
Veriflow Meters and Veritrol
Gas Analyzers • Draft Gages
Combustion Test Sets • CO₂ Recorders
Electronic Oxygen Recorders
Electronic Flowmeters
Electronic Feed Water Controls
Miniature Remote Indicators

hays
CORPORATION

MICHIGAN CITY 32, INDIANA

VOLUME 3
NUMBER 2

Published by Industry and Power Publications

consulting engineer

FEBRUARY 1954

FEATURES

- | | |
|----|---|
| 20 | The Key to Engineering Ethics
<i>Frederick H. McDonald</i> |
| 24 | Demineralization vs Evaporation
<i>Dr. S. Baron and I. Gabel</i> |
| 28 | The Engineer's Status in Product Design Organizations
<i>Charles H. Standish</i> |
| 31 | Rehabilitating a Concrete Viaduct
<i>Joseph G. Conrath</i> |
| 34 | The Pittsburgh Offer
<i>Staff Report</i> |
| 36 | Cybernetics and Product Design
<i>Kendrick Porter and Edward A. Mahoney</i> |
| 41 | The Place of Management Engineering
<i>Stanley P. Farwell</i> |
| 44 | Liquid Level Control
<i>S. D. Ross</i> |
| 49 | The Range Finder
<i>Dr. Gerald J. Matchett</i> |
| 53 | The Legal Aspect
<i>Melvin Nord</i> |
| 57 | Utilities Schedule New Construction |

DEPARTMENTS

- | | |
|-------|-------------------------------|
| Cover | Personality—David B. Steinman |
| 10 | Readers' Comment |
| 14 | Scraps & Shavings |
| 17 | Economic News Notes |
| 18 | Atoms in Action |
| 60 | News |
| 68 | Men in Engineering |
| 74 | Booklets |
| 81 | Meetings |
| 82 | Books |
| 84 | Advertisers' Index |

Editor, Hunter Hughes

Associate Editors

A. M. Steinmetz	H. A. Bergen
J. E. Hinkley	F. D. Hirschfeld
J. C. Dean	

Art Director, Jack Knuth

Art Editor, Len Sentowski

The Engineering Index Service
in Public Libraries lists articles
from CONSULTING ENGINEER.

Publisher, E. R. Gauley

Production Manager, F. C. Donohue

Circulation Manager, John B. Klein

Representatives: See addresses p 84

New York; Newark, N.J.; Chicago

Philadelphia; Cleveland

Los Angeles

NBP CONSULTING ENGINEER is published monthly at 420 Main Street, St. Joseph, Mich. Subscription one year \$5.00; outside U. S. price is \$10.00; single copy 50 cents. Acceptance under Section 34.64 P. L. & R. authorized by U. S. Post Office, Form 3547 requested. Copyright 1954 Industry and Power Publishing Company.

BPA

FEBRUARY 1954

5



Excellence in Design

—Starts on front cover

year he teamed up with Holton D. Robinson, builder of the Williamsburg and Manhattan Bridges, to enter a design for the Florianopolis structure in

an international competition. Their prize-winning design attracted world-wide attention; it substituted structural eyebars for steel wire cable in a new type of suspension structure.

The fledgling firm of Robinson and Steinman went on to design a similar structural steel suspension bridge in Australia. Then Dr. Steinman was retained to design a high, cantilever bridge in California which was the first to be designed against earthquake forces and to be equipped with hydraulic buffers as safeguards against earthquakes.

Young engineer Steinman could be thankful in retrospect that the Roaring Twenties were to bring with them a robust period of bridge construction. In the midst of it, he hit upon the idea of fostering and promoting architectural excellence in bridge design. "I became a one-man campaign for 'beauty in bridges;' I toured the country with illustrated lectures showing how beautiful bridges could be made. My writings on the subject were published around the world, translated into many languages."

The economy and beauty of his bridges have won wide praise among bankers, business men, and community leaders concerned with local government developments—including bridges. He usually astonishes his backers with bridges that cost them much less than they expected to pay. Dr. Steinman is a six-time winner of the American Institute of Steel Construction's annual awards for the most beautiful bridges built in this country.

In his engineering, Dr. Steinman is continually leaving bench marks for other bridge engineers to shoot at. His Henry Hudson Bridge over Spuyten Duyvil remains a model of steel arch construction. This construction had been the subject of his undergraduate thesis 25 years earlier; he now has built it, proving contentions that were disputed when the bridge was first proposed. His Thousand Islands International Bridge, over the St. Lawrence River, called for singular versatility; it includes five types of spans linked to make 8½ miles of crossing. In all, Dr. Steinman has been associated



with the design of some 300 bridges at home and on every inhabited continent excepting Africa.

Today, at 67, he is hard at work in his Liberty Street office on plans for the \$96,000,000 Straits of Mackinac Bridge in Michigan. He is concluding the negotiations leading to the design of the world's longest bridge—a magnificently planned, cable-type suspension bridge which would span the Messina Strait between Italy and Sicily.

His 500 books and technical papers are perhaps capped by his work on an aerodynamic theory of bridge oscillations (of special pertinence in cases like that of Tacoma's "Galloping Gertie" which collapsed in 1940). His papers on this subject won the ASCE's Norman Medal, and the highest award of the Scientific Research Society of America. Many honorary degrees, medals, and professional citations—Dr. Steinman's is the second longest listing in *Who's Who*—testify to the diverse achievement and interests of this busy engineer.

There is a thread of inspiration in this man of soft features and clear eyes which connects his poetry

in steel and concrete with his poetry of the written word. He has written a book—*The Builders of the Bridge*—about the Roeblings and their Brooklyn Bridge. This is perhaps his proudest achievement outside the field of engineering. But a line of continuity exists in that this bridge, in whose shadow he spent his early days, later came

under his professional wing; it was Dr. Steinman who designed changes to eliminate railway track and triple the vehicular capacity of the bridge—this some 70 years after the bridge was completed.

He has written a book for children called *Famous Bridges of the World*. He also indulges a penchant for poetry in the literal sense. Here are some of his lines apropos of his life's work:

*A bridge of strength and grace in
mystic blend*

*Embodies spirit treasures that transcend
The steel and stone. The builder's
dream is there,*

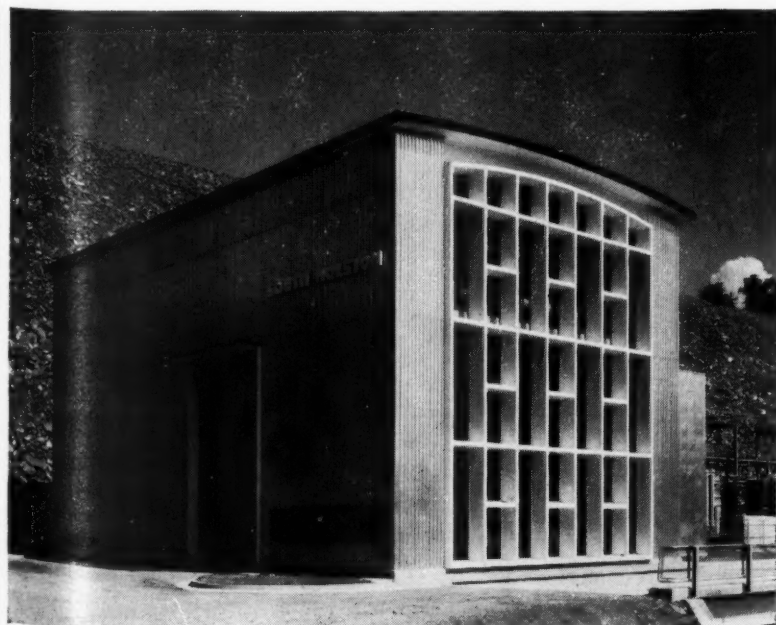
*Each curve a song, each soaring line
a prayer.*

In prose, Dr. Steinman resolves his thoughts like this: "Whatever we may accomplish will in turn be eclipsed by those who follow after us. In whatever we do—in whatever we build—beyond the stone and steel, the calculations and the plans—the one priceless ingredient is the spirit of consecration. That includes the qualities of vision, devotion, inspiration, and integrity."

for ease of construction and maintenance



South Holston Dam powerhouse



Tucked away in remote valleys in Tennessee, these buildings house TVA generators and controls. Many are unattended, operating either automatically or by remote control.

Alcoa Aluminum was used for wall panels, windows, railings and trim because it was easily transported to these hard-to-reach locations and quickly erected with a minimum of equipment. It also gave these buildings freedom from maintenance, a costly item in these sparsely settled sites.

In your next building, consider aluminum for places exposed to wear and weather—wherever maintenance will be a problem, wherever you want distinctive appearance and rugged, lasting good looks.

Alcoa engineers have had a part in nearly every pioneering use of aluminum in the architectural field. They will be glad to work with you. Call your local Alcoa sales office or write: ALUMINUM COMPANY OF AMERICA, 1891-B Alcoa Building, Pittsburgh 19, Pa.

ALCOA 
ALUMINUM

ALUMINUM COMPANY OF AMERICA



ALCOA ON TV brings the world to your armchair with "SEE IT NOW" featuring Edward R. Murrow, Tuesday evenings on most CBS-TV stations.

All buildings designed by Tennessee
Valley Authority Design Department.
Constructed by TVA Construction Department

DIAMOND BI-COLOR WATER GAUGE

with
"HI-LITE"
Illuminator



There is no guessing about boiler water level when you use the Diamond Bi-Color Water Gauge. It makes use of an unvarying optical principle (the difference in refraction between water and steam) to always show water green . . . steam red. With proper illumination, the water level is unmistakable . . . whether viewed directly . . . through a system of mirrors . . . or on control panel by the use of Diamond "Utiliscope" (Wired Television).

A big improvement over other light sources, the "Hi-Lite" Illuminator uses standard high-intensity lamps similar to automobile "sealed beam" headlights. The gauge will thus retain visibility with much longer time between gauge cleanings. Use the coupon below for further information.

6706

SEND TODAY

DIAMOND POWER SPECIALTY CORP. CE
LANCASTER, OHIO

Please send me without obligation a copy of new Bulletin No. 1051 explaining the advantages of Diamond Water Gauges and Water Columns.

NAME _____

COMPANY _____

ADDRESS _____

DIAMOND POWER SPECIALTY CORP.
LANCASTER, OHIO
Diamond Specialty Limited—Windsor, Ont.



READERS' COMMENT

Selected for inclusion

Sir:

One of our divisions is making up a package of material for use within and outside the Commission. Your article "Industry and Atomic Power," CONSULTING ENGINEER, July 1953, was selected for inclusion because it is brief, attractively illustrated, and summarized in tables.

Norman H. Jacobson, Chief
United States Atomic Energy Commission

Washington 25, D. C.

"Simplified Drafting"

Sir:

The article "Nobody Wants to be a Draftsman" by Jack Hinkley, appearing in the November issue of your excellent magazine CONSULTING ENGINEER, has been called to my attention by several people from both engineering and drafting circles. They noticed, of course, how closely it followed *Simplified Drafting Practice*, by Messrs. W. L. Healy and A. H. Rau, published by John Wiley & Sons, Inc., 440 Fourth Avenue, New York 16, New York.

We are pleased that your magazine gave such liberal space to the subject of Simplified Drafting, but were disappointed that the usual credit was not given to the source of the material. We would have appreciated the publicity that such an acknowledgment would have given our book.

W. L. Healy, Supervisor
General Electric Company
Philadelphia 42, Pennsylvania

● WHILE MESSRS. HEALY AND RAU'S BOOK WAS MENTIONED IN THE ARTICLE, MORE PROMINENT CREDIT SHOULD HAVE BEEN GIVEN.—ED.

"The sweeter sound of woman's praise"

Sir:

Thank you for the careful and effective way in which you have edited and presented the article ["How to Hire (and Hold) Engineers"]. You did a wonderful job.

We hope your readers will consider the article constructive and challenging in many ways.

We plan to give the article wide distribution among employers in many different fields, because of its prestige value as well as the general usefulness of the information it contains.

Katheryn H. Power
Public Relations
Pittsburgh 19, Pennsylvania

Push for Chicago

Sir:

Thank you very much for the fine push for Chicago as the locality of the future headquarters of the national engineering societies.

The article is very well done, and I am hoping it will receive wide attention from all of the leaders of the various societies.

S. S. Howe
Illinois Institute of Technology
Chicago 16, Illinois

● IT DID—ED.

Favor granted

Sir:

We are sending enclosed the draft of an article on the free piston engine, in which we borrowed from the staff report in your August issue. We should consider it a real favor if you would offer any comments or criticisms which might make this article more accurate or more interesting.

As you know, the *Industrial Bulletin* is sent monthly to research, financial, and industrial executives, and attempts to bring to their attention authoritative information on recent technological developments.

H. M. Ahearn
Arthur D. Little, Inc.
Cambridge 42, Massachusetts

● A GOOD STORY FOR A VALUABLE LITTLE PUBLICATION—ED

"Twas good advice, and meant . . ."

Sir:

I should like to offer some entirely personal comments about your editorial policy. A magazine I would

CONSULTING ENGINEER

enjoy would be one which treats engineering as the *Scientific American* treats the field of science. Engineering has become so diversified that there seems to me to be a real need for a magazine which will tell non-civil engineers what this prestressed concrete business is about, will tell non-mechanical engineers about cyclone furnaces, control circulation and critical pressure boilers.

On the contrary I have thought that articles which dealt with rather specific design problems such as application of capacitors or design of distribution systems were out of place in your magazine.

The articles which have dealt with organization and administration of engineering firms seem to have a logical place in your magazine. . .

I have a couple of suggestions for articles which would interest me and perhaps other readers. One would be an article about the interrelation of architects and engineers on projects which intimately combine both fields. An example might be the Arena at the State Fair Grounds, in Raleigh, North Carolina which is pictured in *Life* magazine for January 4. There are substantial engineering problems in this project but the *Life* article reads as though it were the work of only an architect. How did it actually get designed? My second suggestion is for an article which would discuss the methods by which more public utilities arrive at their electric power rates. In theory a public utility is allowed by its State Public Utilities Commission to recover its operating costs and earn a certain return on its investment. However, in practice the application of these concepts and the establishment of rates is a complex subject.

J. C. Hitt

Jackson & Moreland Engineers
Boston 16, Massachusetts

"Beauty is truth . . ."

Sir:

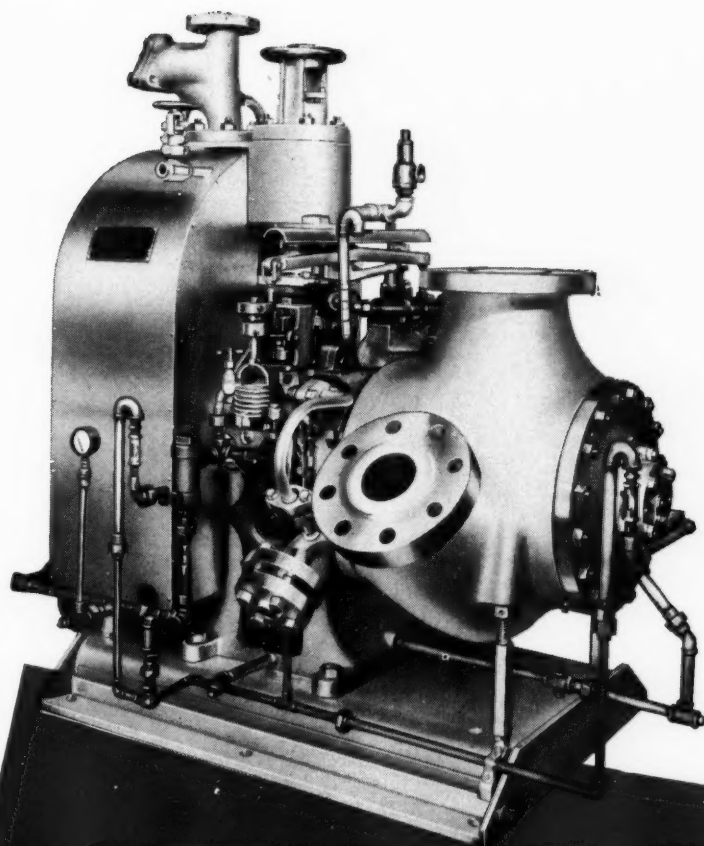
This is to express my appreciation for the beautiful executed article of mine which appeared in the January issue of your excellent magazine.

The presentation, both from the editorial and artistic viewpoints, is superb and far above the customary engineering publication. There was just one small error in the article. On page 33, "8 B 18" should read "8 B 13."

Paul Rogers

Rogers & Snitoff, Inc.
Chicago 10, Illinois

● CORRECT. THERE IS NO "8 B 18" ROLLED STEEL BEAM. 8B BEAMS COME ONLY IN 13 AND 15 WEIGHTS.—ED.



ANNOUNCING!

the new

Type "DE"

Coffin turbo pump

Superbly engineered to keep pace with increasing steam pressures, the new type "DE" is a highly efficient single-stage, high-speed, steam turbine-driven centrifugal boiler feed pump.

At no extra cost, unit is equipped with both a speed-limiting governor and a pressure regulator operated by a powerful oil relay which prevents over-speeding and provides shut-down upon loss of oil.

The unit has varied industrial uses, particularly in the oil and chemical fields for boiler feed and other services. The pump covers a Volumetric Range to 800 GPM, Discharge Pressure to 1000 PSIG, Steam Temperatures to 850° F., Exhaust Pressures to 80 PSIG, and Liquid Temperatures to 325° F. For special installations these ratings can be exceeded.

Write for the new, 6 page illustrated "DE" Bulletin E 154.



THE

J. S. COFFIN, JR.

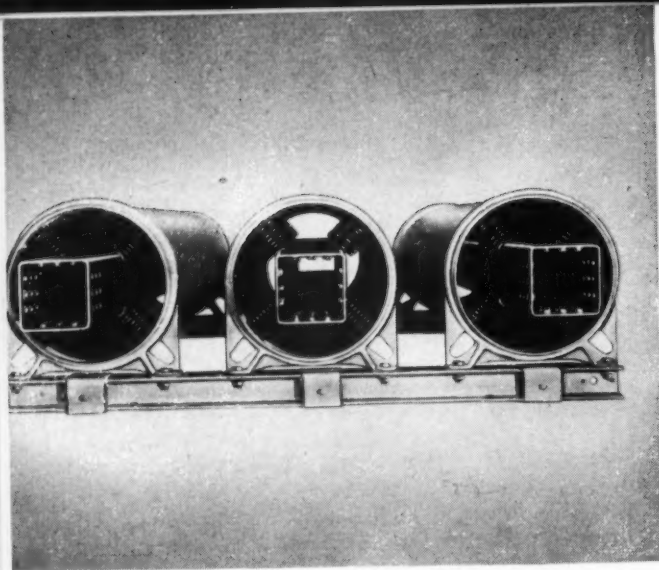
COMPANY

326 South Dean Street Englewood, New Jersey

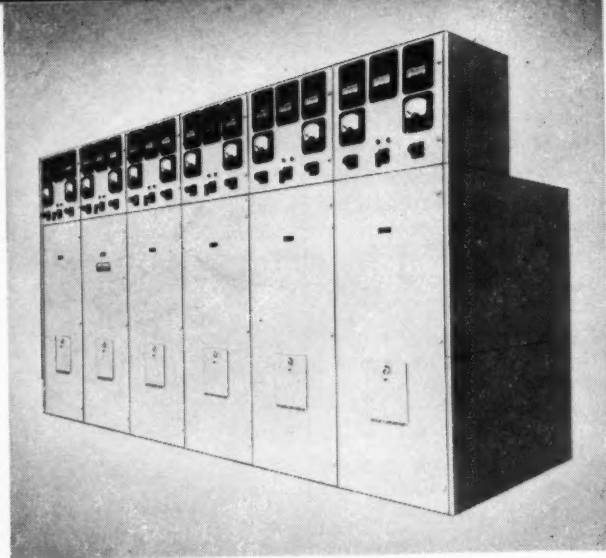
Cable Address: COFCO

Representatives in the United States, Canada, Europe, and the Far East





METAL-ENCLOSED BUS STRUCTURES



METAL-CLAD SWITCHGEAR

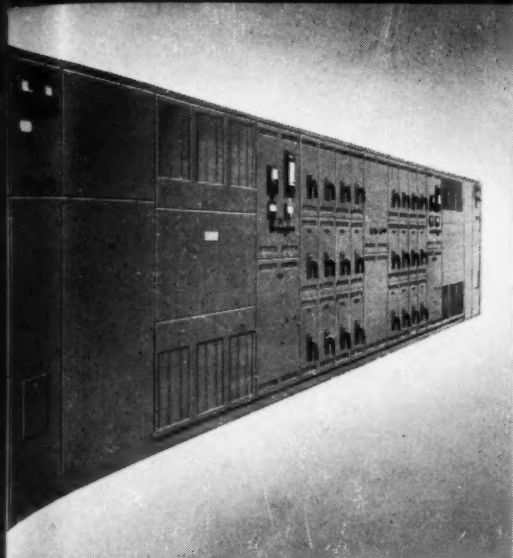


UNIT

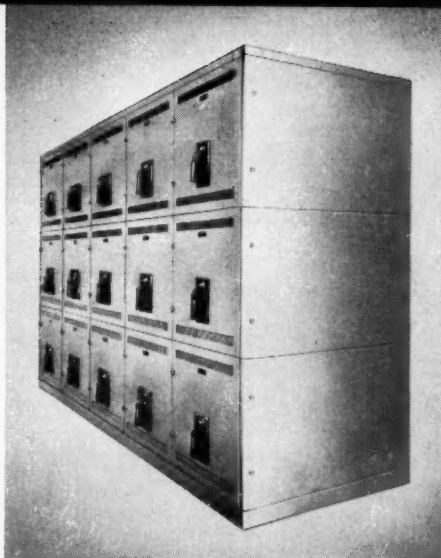
Put I-T-E in



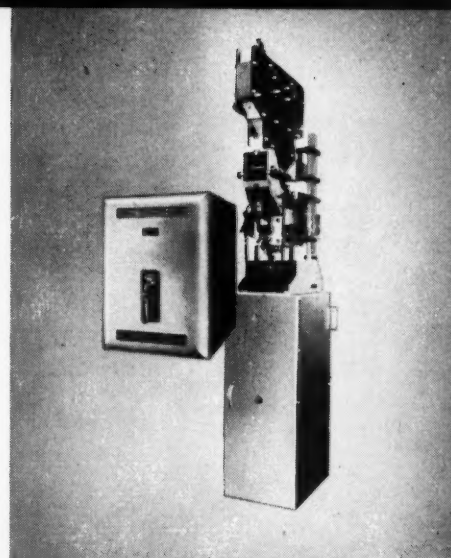
TH



UNIT SUBSTATIONS



LOW-VOLTAGE SWITCHGEAR



LARGE AIR CIRCUIT BREAKERS

in your power plans...

for Dependability, Safety, and Over-all Economy

A complete line of Quality Switchgear Equipment

From generation to utilization, I-T-E quality equipment serves every industrial and commercial application. Whether your plans include bus structures, metal-clad or low-voltage switchgear, unit substations, or individual circuit breakers—you are assured of I-T-E's many *extra-service* benefits, which include:

1. selection and application of equipment
2. preparation of specifications
3. coordination of all job requirements

Power is fundamental in any new plant construction or expansion. Power distribution systems must be planned to assure maximum dependability of service, safety for personnel and equipment, and *over-all* economy—from initial planning . . . through the life of the equipment.

Furthermore, it is important to plan power systems with an eye to the future. They should be adaptable to changing plant requirements for many years ahead.

For these reasons, it pays to include I-T-E quality products in your power plans. For over 65 years I-T-E has set the standard for the industry—through engineering skill, design refinement, and introduction of new ideas and thinking.

For details, contact the I-T-E field office nearest you. Look in your classified telephone directory under "Electrical Equipment."



I-T-E CIRCUIT BREAKER COMPANY

19TH AND HAMILTON STS. • PHILADELPHIA 30, PA.

SWITCHGEAR PRODUCTS



SCRAPS & SHAVINGS

THE "SHORTAGE of engineers" is just about as phony as a rubber ruble. Yet, a week never passes but some organization issues a press release or publishes a pamphlet bemoaning the lack of engineers and scientists. For several years the Engineering Manpower Commission of Engineers Joint Council has been publishing a Newsletter devoted solely to increasing the pool of engineering and scientific manpower. This group consistently takes the stand that there are not enough engineers, that enrollment of engineering schools should be increased, and that engineering students should be exempt from the draft. The Scientific Manpower Commission has just joined with the Engineering Manpower Commission in the publication of that Newsletter.

Now the National Association of Manufacturers is getting into the act. On January 22, the NAM issued a press release which begins, "Dear Editor: Our nation today is faced with a tragic shortage of scientist and engineers."

Tragic, indeed! The current shortage is not engineers but coffee. The way we know there is a shortage of coffee is because the price of coffee has obviously risen in just six weeks. We have not noted a similar increase in the price of engineers in six months, or for that matter, in six years.

The coffee situation confirms our opinion that the law of supply and demand is still in effect. And we are convinced that the law applies to

labor and the professions in just about the same way it applies to coffee. The difference is that coffee is paid for in cash, while engineers are paid in cash, professional prestige, and job security. Any employer who wants to test this statement need only place an advertisement in the classified section which states, "Wanted, engineer for permanent position in strictly engineering work of professional caliber. Income equal to that of our corporation lawyer." The employer who placed such an ad would quickly reject the idea of a shortage of engineering talent.

It is a simple fact that if the price is right, the engineers are available. Currently, engineers have found that they can make more money in sales or management. On top of that, our own scientific societies are constantly encouraging young members to "progress" to management jobs rather than stick to professional engineering.

Most consulting firms recognize that there is really no shortage of engineering talent. Salaries and professional prestige in the consulting profession are higher than for engineering work in industry; under such favorable conditions, engineers are easier to come by.

So far as we know, engineers are the only professional group idiotic enough to personally finance a major campaign to increase the number in their group while at the same time they sit around and gripe about low pay. The medical profession does not pay the American Medical Association to go around screaming about the shortage of doctors. On the other hand, hundreds apply for entrance to a medical school for every one student who is admitted. It is high time we instructed the Engineering Manpower Commission to "cease and desist." It is time we worked with our engineering schools to see that entrance requirements are made more stringent. Only in this way will the supply be such that those with a good engineering education can demand proper payment for professional services throughout their careers.

KIRKLAND ILLUMINATED MESSAGE ANNUNCIATORS

The MLBR series of Annunciators represents the latest in design of Visual Supervisory Systems. Standardized parts influence lower costs. Plug-in relays eliminate the need for skilled electricians to service the system. Attractive appearance is effected with the faceplates mounted flush with the surface of the panel, (inlaid). The engraved message gleams brightly when the bulbs behind the plate are lighted. Installed in many of the new power plants.

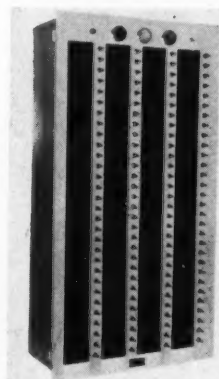
All MLBR systems employ circuits designed in particular to prevent the loss of the alarm signals in the event of the abnormal condition. A wide variety of services can be furnished.

A WIDE VARIETY OF SERVICES — WRITE FOR CATALOG

THE H. R. KIRKLAND CO.

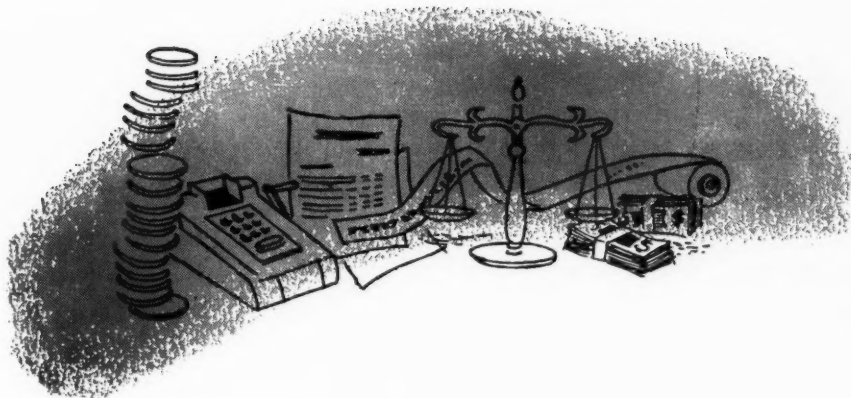
MORRISTOWN, N. J.

— Established 1930 —



ECONOMIC NEWS NOTES

E. F. Mac Donald
INDUSTRIAL ECONOMIST



▷ **TROUBLE AHEAD**—In running counter to the consensus in his pessimistic stand on the economic outlook, Prof. Colin Clark, of Oxford University, stresses the high level of construction costs. He looks for this to have a more direct impact on the building volume in this country than the declining rate of family formation. In his widely reported appearance last month at a forum of the National Industrial Conference Board, Clark stated that he expected a severe downturn and would feel better if the Administration would immediately begin to combat the recession.

▷ **SLUM REHABILITATION**—"Federal assistance is justified for communities which face up to the problem of neighborhood decay and undertake long-range programs directed to its prevention." CE's (with municipal clients) and city officials should note this significant statement in the President's message to Congress and recommend formulation of plans accordingly. The basic and long-run importance of such capital projects transcends their value of potential pump-priming agents.

▷ **LEASE-PURCHASE PLANS**—Leasing arrangements with options to buy are getting a big play in efforts of tool makers to boost new orders. Kearney & Trecker Corp. is one of the latest to come out with such a plan. They offer a three-plan choice, all on a 7-year basis. K & T points out that the lease deal frees working capital for other uses. Yale & Towne also report leasing to be on the increase at their shop. They have worked out a three-way plan combining time payments, leasing, and option to purchase. Interested parties should be very careful about taking rental payments as tax deductions. The Internal Revenue Service is quite touchy in this respect.

▷ **INVITATION TO DISASTER?**—With 70 percent of our industrial capacity and 54 percent of total manufacturing workers concentrated in 50 metropolitan centers, ODM points out that we have a "sitting duck" industrial concentration providing easy targets for enemy attacks. But while ODM argues that such vulnerability should be alleviated through more strategic location of new productive facilities, a trend of industry back to cities was reported to the Great Lakes Industrial Development Council at its June conference. Among reasons cited for the reversal of the rural industrialization trend were failures to find lower tax areas, lack of public utilities and transportation, and inadequacy of schools, housing, and community planning and cooperation.

▷ **NO LETDOWN**—It was feared in some quarters that the expiration of the excess profits tax and the end of "inexpensive" tax dollars would reduce considerably the outlays this year on research and development. Recent reports, however, indicate that such spending will continue at the level reached last year when, for a corporation subject to excess profits tax, the net cost of a dollar spent for research was around 18 cents. Pay-off prospects and force of competition are the important factors in continuing research and development programs, not the availability or non-availability of "cheap tax dollars."

▷ **REQUIRED READING**—Your guess as to what's ahead may be as good as theirs, but you can take advantage of the thinking of topnotch economists and monetary experts by reading the reports of the hearings and panel discussions held in February by the Joint Committee on the Economic Report. Called in by the Congressional committee to analyze the Economic Report of the President, the nation's experts have examined current business conditions and spelled out their opinions of the economic outlook. This is undoubtedly the best analysis of the situation that you'll come across.

▷ **PEAK LOAD**—The heavy construction industry should enjoy at least another decade of capacity operations, according to engineers at the recent Associated Equipment Distributors convention. They pointed out also that the principal difficulty in the industry was the short supply of technically-trained top executives capable of directing operations.

▷ **ODDS AND ENDS**—One of the President's recommendations, if approved, will bring self-employed engineers and architects under Social Security . . . Regardless of outcome on new approvals and appropriations, carryover of appropriated but unspent funds will keep outlays for military construction in fiscal 1955 at the level reached during the current period . . . Looks like plenty of work for civil consultants in Venezuela. One-third of the budget there last year went for public works, and under a comprehensive public works program, 450 projects were reported completed last year, including a \$6 million-a-mile highway . . . VA loans financed about one out of every five 1- and 2-family homes built in 1953 . . . Electric utilities will add a record 25.5 million kw to generating capacity this year . . . American shipyards face the prospect of empty ways before this year is out. The record peacetime volume of completions last year was accompanied by a record of practically no new orders.

ATOMS IN ACTION

UTILITIES SECURITIES, as affected by the advent of commercial atomic power, was the subject of Eldred H. Scott, controller of Detroit Edison, in speaking before the American Finance Association's recent annual meeting. Referring to the introduction of automatic dialing in the telephone industry, he said, "Perhaps the introduction of nuclear power will be just that in the electrical industry. Regulatory precedent in the gas and telephone field should allay any fears as to the ability of most electric utilities to recover from customers any large write-offs of property because of the introduction of nuclear power. Utilities could easily prove that their property losses were caused by unforeseen occurrences . . . Their (electric utilities) eager approach to the new nuclear energy resource augurs well for the owners of electric power securities. The eventual commercial feasibility of nuclear power has been generally accepted for a long time. There has even developed a healthy competition among the several utilities as to methods of development."

URANIUM LEASING of lands previously closed to mining will be opened under a new regulation announced by the AEC. The new regulation covers areas previously committed to oil and gas leasing.

PROGRESS on many fronts — Locating oil deposits by gamma-ray well logging has been just announced as a method to identify rock strata; in addition to radioactivity quantity, the new method measures the quality of radioactivity at various depths in a well. And General Electric announces it has completed its 225-foot diameter steel sphere for housing a test atomic power plant. The AEC announces that a Joint Task Force 7 will conduct a further phase in continuing weapons tests of all categories; men and materials are now on the move to the Pacific Proving Grounds. One thing that is not in the cards just now, however, is the replacement of conventional power plants by nuclear power for cargo ships; the present outlook for marine nuclear propulsion shows that nuclear energy cannot compete on a straight economic basis although some advantages do presently exist in extended cruising ranges, higher speeds, reduced fuel storage space, and reduced weight.

REACTORS AND ACCELERATORS make news. Pennsylvania State University has just been allocated the fissionable material required for a nuclear reactor. Penn State will spend an estimated \$250,000 to build a low-power "swimming pool" (cooled and moderated by ordinary water) reactor rated 100 kw; it will be used for research and student training. The Brookhaven National Laboratory has obtained AEC approval on design and construction of an alternating-gradient, ultra-high-energy particle accelerator. The \$20 million machine will produce proton beams having energies up to 25 billion electron volts; it will be completed in five or six years.

THE FIRST UNIT of the Ohio Valley Electric Corp. will be on the line next January 1, according to Philip Sporn, president of American Gas and Electric, one of the OVEC's associated firms. The OVEC project will supply the AEC's Portsmouth, Ohio gaseous diffusion plant with a 1,800,000 kw-hr demand capability and 15 billion kw-hr yearly consumption.

—and perhaps for the other professions to clean theirs.

The article "Engineers Need Ethical Discipline" emphasized that:

1. Professional recognition requires the conscious use by the engineer himself of the principles that will elevate his economic, technical, and social status.

2. Those entering the profession do not automatically make their status differ from that of non-professional men.

3. The employment trend is for engineers to become depersonalized units of mass administration and production.

The unusual number of comments, orders for additional copies, and requests for permission to reprint that have been received by *CONSULTING ENGINEER*, and the correspondence received by the writer, amply confirm these facts and their neglected significance to professional status.

Responsibility

Many engineers place responsibility on the profession and its Societies. Often they deplore the lack of a single-front organization to act for engineers with the unity of the American Medical Association, the American Bar Association, and the American Institute of Architects. Many also conclude that the divisive forces in engineering will not soon be reconciled to a single professional membership, authority, and voice.

Engineers, whom I rate as realistic, see the increasing number of engineers; and they see the mounting proportion in industry who are subject to unionization. They consider that continued dependence on solving our professional problems through general responsibility will fail in the future even more than it has up to now. These men are convinced that the practical solution is to look to the future by conditioning engineering students more thoroughly on professional standards.

In discussing such instruction with educators, I found them already lamenting overcrowded curricula. But several suggested the writing of a book on the special problems of practice and employment under modern conditions for use by engineers, with a larger use as a supplementary text or collateral reading at college. My inquiries to publishers brought a surprise. All said "An apt book—but we do not see sufficient demand!"

Survey

This led me to explore the current academic outlook on professional standards. A memorandum was prepared on the educational implications of my article, and *CONSULTING ENGINEER* supplied me with reprints to accompany it. In addition, a survey sheet was developed to determine:

1. Faculty attitudes and current instruction in

ethics and professional standards.

2. Alternatives other than college instruction to equip engineers for gaining professional status.

3. The possible use of a supplementary text on "The Modern Engineer's Practice and Employment."

This material was sent to the Deans of Engineering of 120 universities and colleges. These ranged from the largest to the smallest, with at least one in every state and the District of Columbia.

Sixty-six replies were received from 37 states and the District of Columbia. These show that nearly all educators see a vital professional problem. But the answer to the impelling Question No. 3 is that by no means do present academic concepts include enough student conditioning on professional standards to justify preparing a book.

The reason was shown by Question No. 2. Several suggested that an alternate to college instruction is through registration and licensing. The prevailing suggestions reflect the major college and practicing outlooks—to place responsibility on the profession and its Societies.

Plan of Action

Gratifyingly, however, the survey was amply justified. The replies to Question No. 1 on current instruction and faculty attitudes made a direct path to a promising solution of the problem!

Only six replying educators say they use texts on professional standards, and the titles are more weighted with law, economics, contracts, and specifications than with ethics. Several colleges use material prepared by their faculties or obtained from Engineering Societies. The rest use suggested reading, faculty lectures, and talks by guest engineers.

A frequent statement was: "These things are discussed informally with students at bull sessions, in the student chapters of the Societies, in seminars, and at other gatherings."

Thus the trend is to treat professional standards informally at college. They are relegated to chance gatherings. In general, they seem to be regarded more as the character builders of Boy Scout work than as essential to classwork for preparing engineers to practice. Professionalism is not indoctrinated with the persistence or with the realism of technology.

The field evidence cries aloud that it is past time for educators to re-assay this lip service to professional standards. Our faculties are doing a monumental job in preparing their students in basic technology; but their graduates have little if any preparation in the human problems of applying technology for their own, the profession's, or society's good!

I see this as the fault of those of us already in practice. Educators can get their measure of instructional needs only from those who use their

graduates. We in practice have not admitted to ourselves, much less to educators, that current failures in the human conduct of practice and employment are hurting us and damaging the profession.

Definition of Ethics

I find a key to the problem in this typical statement (or misstatement) on ethics: "These things are a part of one's character and are gained by accretion in early childhood or in one's family."

This prevailing view deals with the precepts that parents and teachers use to instill the honesty and moral values of personal rectitude. 'Thought will show that these are but abstractions in comparison to the realism needed to impress and implement professional codes of conduct—which take personal rectitude for granted. Such codes are forged from the age-old experience of our predecessors, to combat the evil and ignorance that harass those who have the precious intangibles of knowledge and judgement to offer mankind. Such intangibles have none of the safeguards of possession, transfer, or use that characterize commodities.

Today's professional codes are the working disciplines devised by learned men to protect themselves and society in the ownership, transfer, and use of knowledge. These disciplines are reciprocal—they guard professional men against the bad and backsliding among their kind, and against abuse by outside traders and cheaters. They guard laymen against exploitation, and against their own misuse of the fruits of professional service.

Our professional error, and likely the error of the other professions, is that we have not recognized two distinct kinds of ethics. Personal ethics cover the probity which is taken for granted by decent men as the attribute of other decent men. Professional ethics cover the techniques of attitudes and actions which professional men have agreed upon to bring respect for truthful findings, informed judgement, and knowledgeable procedure, and to insure their acceptance and use under professionally set conditions, by their own kind and by all other mankind.

Honesty is not in that definition. It is assumed as the requisite of decency. It is not peculiar to or the monopoly of professional men. When its breaches bring damage—by liars and thieves who are butchers, bakers or engineers—these can be handled under the law. But there is no legal recourse for breaches of the ethical codes which protect professional men and society from declared misconduct that is beyond the law.

This protective implementation has not been recognized as the essence of every contact engineers make with each other, with clients or employers, and with the public.

The reason is people.

We are not taught, and too few of us have pre-

pared ourselves to utilize the fact, that the use of engineering depends upon humans—that the benefits to the users of engineering and to engineers depend upon the kind and the plane of relations engineers have with humans. We need to learn that adherence to professional standards calls for and produces more than personal rectitude. It is technically, financially, and morally the most productive way of handling our human relations!

Determining a Code of Ethics

To be practical, we need to find for ourselves, and to see that the engineers of tomorrow are taught, the working techniques called ethics and professional standards which can be made to protect us against fee-cutting and pirating by other engineers; against the demand that engineers compete on a price basis for the design of public works; against clients with staffs of operating engineers who expect outside engineers to do only the difficult part of design, but accept full responsibility for results, at part fees; and against non-engineer employers who jeopardize the reputé of their engineers by demanding figures and drawings without accepting engineering judgement on the use of calculations and design. Furthermore, we need to combat the de-professionalizing influences of unionization.

None of these is dishonest or illegal. They are abuses in the human relations of engineering that can be made safe for engineers only by resort to the disciplines of our codes of practice. These codes thus emerge as neither visionary, static, nor optional. Adherence to them is proven as essential to the safety of the business of engineering as adherence to science is to the technology of engineering.

Abuses

That we in practice are at fault in realization is witnessed by the number of educators who indict the profession—and conclude that little can be done in college to fix professional standards. "Most graduates", say many educators, "are enthused with the ideals of the profession, only to be disillusioned by the abuses they find in their first few years in the field."

Regardless of whether such abuses come from a lack of morals or the honest lack of professional know-how, they mean that we have chronic and observable breaches of professional standards. Yet, when we consider remedies, we come to grip with grim realities. Who has the reach to name the guilty? Who has the force to change their practices?

Our fault and remedy is in the individual. We have too many technically qualified engineers who have not been taught the true significance of professional standards or, more vitally, how to make them effective. When we teach professional attainment in the abstract—by precept only—we do not

equip engineers with the armor to defend it or the weapons to advance it!

The alternative is obvious. We must endow our graduates with more than personal rectitude. We must equip them to recognize and guard themselves against breaches of professional standards by other engineers, and by clients or employers.

Key to Ethical Conduct

Here is a challenge in realism. It requires that we determine, by research, the techniques that the experience of sincere and prideful men has shown are necessary to maintain professional status. We must distill the best practice not only of engineers in every field, but of the reputable practitioners of medicine, law, and architecture.

Once these techniques are determined, they can be evaluated and formulated for wide use. Specifically, they can be used to teach and equip our engineering graduates to make professional status as tangible as technology.

This emphasis on guided evolution to guarantee the future professional status of engineering may seem of little comfort to those who make up the conscience of our profession today. All of us would like to find a magic house cleaner.

But preparation of the individual is positive. It is within our reach as no other recourse seems to be. It is a path to professional achievement that

will not be strange to engineers, for we daily turn concepts into realities by dealing with their elements—shaping each to serve its part in the whole.

Can we not with confidence turn to shaping each engineer to serve his part in the professional concept that lifts technology from the anvil to the mind?

Here we have the key to ethical conduct in a new approach to professional status—to place responsibility and capacity for maintaining professional standards in the individual engineer.

The prospect that this may be the long sought “it” of professional fulfillment is heartening. It does call for pioneering research to determine the techniques to implement a new educational process and objective. Admittedly, it will take time to find and formulate them.*

Yet of this we can be sure: as yearly graduates who are equipped with the know-how of professional status are added to those of us who do maintain it, the integrity and productive plane of our human relations will make engineering richly satisfying to its members, and envied for its rewards to humanity.

*Mr. McDonald is not passing the buck. He is now engaged in research which he hopes will find the techniques to permit ethical standards to be accurately determined, evaluated, and formulated. — ED.

Report of the Ethics Committee To Engineer's Council for Professional Development

WILLIAM F. RYAN, Chairman

J. W. BARKER
C. C. KNIPMEYER

T. H. CHILTON
R. W. SORENSEN

DEAN G. EDWARDS
SCOTT TURNER

C. R. YOUNG

SEVERAL ADDITIONAL engineering societies have adopted Canons of Ethics for Engineers during the last year, bringing the total number to eighty...

Canons of Ethics for Engineers is now generally accepted by the English-speaking engineers of North America. Our efforts to embrace the entire Western Hemisphere have failed because of events that are more or less inevitable while the organization of our profession is so loose and so complicated, and while substantially all fields of professional activity are cultivated by uncoordinated and sometimes competing organizations.

Since its inception ECPD has assumed responsibility for the formulation and acceptance of engineering ethics. When EJC accepted membership in the Pan American Union of Engineering Societies (UPADI), your committee, working through EJC channels, immediately initiated a proposal that the Canons be accepted by this hemispheric organization. The code was translated into Spanish, Portuguese, and French and submitted to the Convocation at Rio de Janeiro in 1950. An international committee was appointed to consider the proposal and report at the New Orleans meeting in 1952. The United States mem-

ber of this committee, unable to attend the New Orleans session, recommended that the chairman of the ECPD Ethics Committee should attend as his alternate. Instead, a member of the staff of ASCE undertook the assignment. At the New Orleans meeting a Code of Ethics was adopted which differs materially from the Canons...

This incident is an outstanding example of the need for “Unity” in the engineering profession. Presumably, in a unified profession, we should not have one Council, representing eight major societies, securing acceptance of one code of ethics in the United States and Canada, while another Council, representing five of the same organizations secures adoption of a quite different code by an organization embracing not only the engineers of these two nations, but our colleagues south of the Rio Grande as well.

Your committee has for a long time pressed for greater recognition of professional concepts, and particularly of professional ethics, in our engineering colleges. It is gratifying, therefore, to learn that ASEE has established a standing committee on ethics whose principal function is to study and make recommendations regarding the place of ethics in engineering curricula.

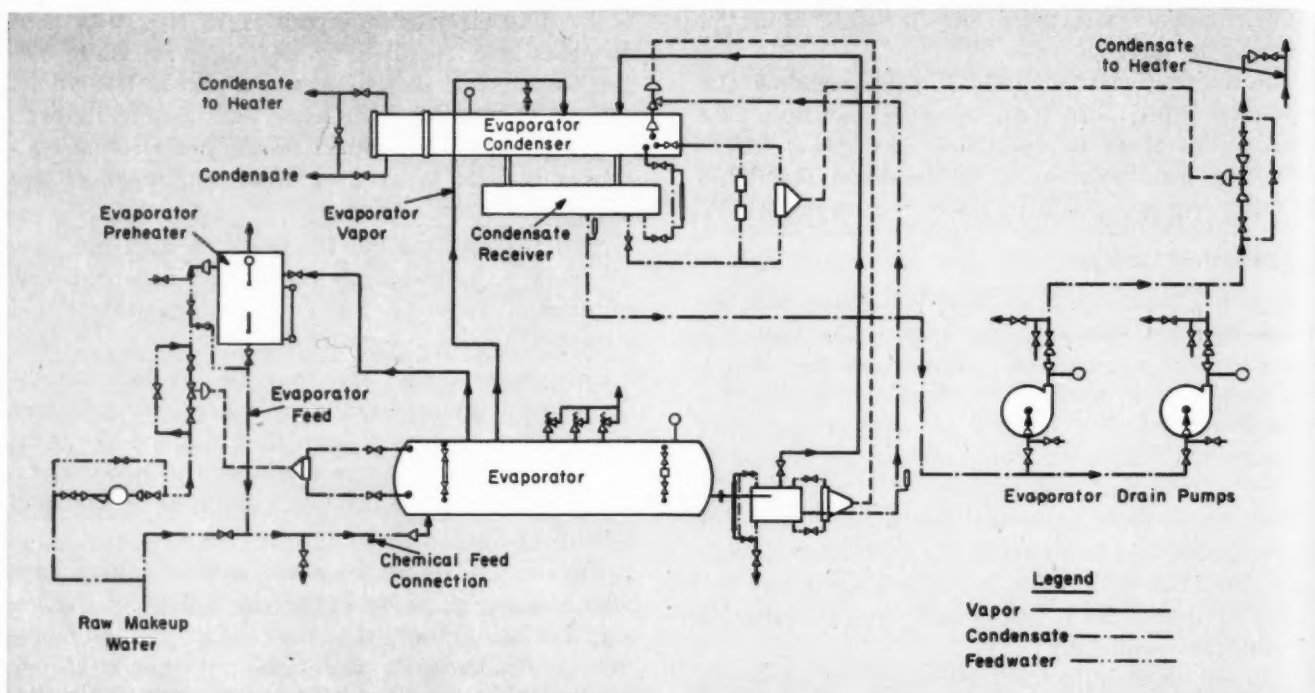


FIG. 1—THIS FLOW DIAGRAM ILLUSTRATES A TYPICAL EVAPORATOR ARRANGEMENT WITH HIGH THERMAL EFFICIENCY.

Demineralization vs Evaporation

For Treating Power Plant Makeup Water

Dr. S. BARON and I. GABEL
Burns and Roe, Inc.



Dr. S. Baron is a graduate of Johns Hopkins University with B.E. and M.S. degrees in Ch.E. and Columbia University with a Ph.D. in Ch.E. He conducted research, development, and pilot plant studies for three years at U. S. Industrial Chemical Co. before joining Burns and Roe, Inc., in January 1950, where he is now in charge of the thermodynamics and heat balance section. He is a member of AIChE, a licensed P.E. in N. Y., and a member of Sigma Xi and Phi Lambda Upsilon.

Mr. I. Gabel received his technical education at the Polytechnic Institute of Brooklyn, graduating with a B.M.E. degree, summa cum laude. For the past three years, he has been associated with Burns and Roe, Inc., serving in the thermodynamics and heat balance section. Mr. Gabel is a member of Tau Beta Pi and Pi Tau Sigma.



IN APRIL 1950, the first complete demineralizing plant to treat boiler makeup water was put into operation at the Waukegan Generating Station of Public Service Company of Northern Illinois. This marked an important change in the method of preparing makeup water for power plants. For 35 years previously, dissolved and suspended solids

were removed effectively only by distillation, a mechanical process of vaporizing water by heat.

Evaporation

The first evaporators used live steam for evaporating the makeup water. The vapor from the evaporator was mixed with exhaust from auxiliaries and

condensed in the condenser. Gradual developments were made in order to improve this arrangement thermally. Exhaust steam from the turbine drives of auxiliaries or extracted steam from the turbine could be used to evaporate the makeup water in place of the live steam. The vapor from the evaporator, either condensed or as vapor, then was piped to the heater or header at the highest pressure available without mechanically moving the fluid.

Ultimately, the insertion of the evaporator between two successive extraction points of the turbine became a fairly well standardized practice. This, in combination with an evaporator preheater, evaporator condenser, and a drip pump, advanced the art of evaporation to its finest point as far as the thermal arrangement of the cycle was concerned. There are very small losses with this arrangement, even with all of the aforementioned components. The only loss that occurs thermally is the heat in the blowdown liquid and possibly some radiation.

From an available energy point of view, the only loss that occurs is the drop in pressure of the bleed steam from the pressure at the higher of the two heaters on either side of the evaporator in the cycle to some point in pressure between the two heaters. This differential must be sufficient to keep the system operating thermally. A flow diagram of an evaporator arrangement of high thermal efficiency is shown in Fig. 1.

Demineralization

Whereas in evaporation the water is purified by vaporization, which separates it from the impurities, in demineralization the impurities pass out of the

raw water to leave behind pure water. The dissolved minerals in water, which are to be removed by demineralization, are present in equal quantities as positively and negatively charged ions. The positive ions are called cations, since in an electrolytic cell they would pass to the cathode, while the negative ions are called anions because of their affinity for the anode.

It has been found that certain natural sands, carbonaceous materials, and resins will exchange loosely held ions and form a chemical combination with the ions in the raw water. If the exchange material initially contains hydrogen ions, the sodium, calcium, and magnesium ions will replace the hydrogen ions, and the water then will contain the corresponding acids of the mineral salts. A second exchanger material, which has a strong affinity for acids, then is used to remove the acids from solution. The first step is cation exchange while the second is anion exchange. When exchange capacities are exhausted, a strong acid solution will restore the hydrogen ion supply in cation exchangers while a strong caustic solution will neutralize the acid and thus regenerate anion exchangers.

Recently, mixed bed demineralization has been developed. This system utilizes a single unit in place of the standard two bed arrangement with separate cation and anion exchangers. The anion and cation exchanger materials are intimately mixed together during normal operation and are separated hydraulically prior to regeneration. Whereas the effluent of a two stage demineralizer normally contains from 0.25 to 1 ppm dissolved solids, the effluent of a mixed bed system has less than 0.05 ppm dissolved solids. In comparison, the

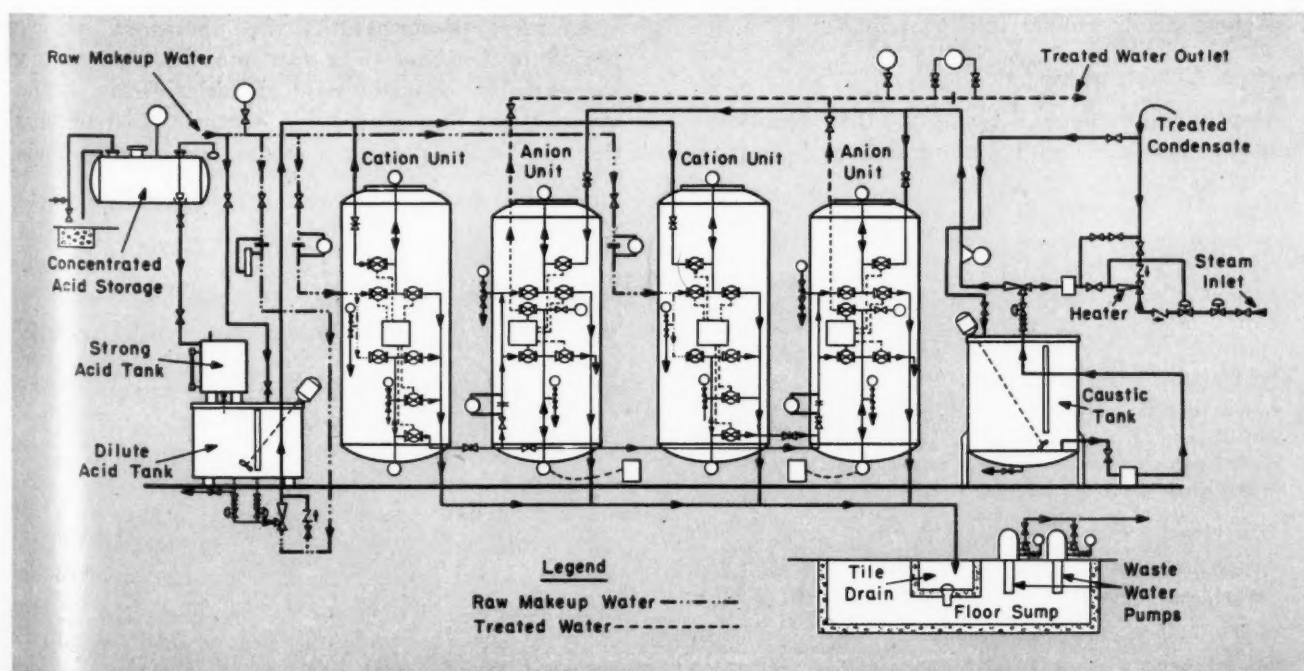


FIG. 2—THIS FLOW DIAGRAM ILLUSTRATES A TYPICAL TWO STAGE DEMINERALIZING PLANT FOR TREATING MAKEUP.

TABLE 1 — REQUIRED EQUIPMENT

Design Capacity, 80 gpm

Evaporator	Demineralizer
2 Evaporators	2 Cation units
1 Evaporator condenser	2 Anion units
2 Evaporator condenser pumps	Regenerating tanks
1 Evaporator preheater	Caustic soda heater
Softener	Injectors
Bleed steam line	Control piping
Vapor lines	Interconnecting piping
Condensate lines	Miscellaneous piping
Miscellaneous piping	Valves and fittings
Valves and fittings	Hangers and supports
Hangers and supports	
Insulation	

best guarantees presently made by responsible manufacturers list a solid content in an evaporator vapor of 0.5 to 1 ppm.

At boiler pressures in excess of 500 psig, silica in the boiler water will distill over and deposit on the turbine blades, forming a coating very difficult to remove. With raw water containing silica, the cation exchanger converts the silica to weak silicic acid which is then adsorbed by the material in the anion exchanger. Similarly, bicarbonates in the raw water are converted to weak carbonic acid in the cation exchanger and then adsorbed in the anion exchanger. If the carbonate content in the raw water is high, chemical costs of regenerating the anion exchanger can be reduced by a decarbonator before the anion exchanger which removes the carbon dioxide in the water before it enters the anion exchanger. A flow diagram of a two stage demineralizer is shown in Fig. 2.

Practical Considerations

At present, there is little doubt that demineralization of boiler makeup water must be given care-

ful consideration when designing central power stations. This is especially true if the solid content of the makeup water is below 500 ppm as there are many advantages to be gained by using this method in place of evaporation.

The capacity of the evaporator in a central station is limited approximately by the amount of steam that ordinarily would be extracted in the adjacent lower pressure heater for feedwater heating if the evaporator were inoperative, the condition being most acute at low loads and high makeup demand. This restriction can be overcome by changing the extraction points in the original turbine design, by closing the bleed line to one of the heaters, or by dividing the evaporator in two or more separate units at different points in the turbine cycle. However, these alternatives are undesirable because they reduce the thermal efficiency of the cycle or are more costly.

Conversely, a demineralizing plant can supply rated capacity at all loads, and can operate with the boiler-turbine-generator units shut down. This makes it ideal for starting up plants with no source of adequately pure water. In addition, with demineralizers, a power plant cycle is thermally more efficient than the same cycle in which an evaporator is interposed. In a present day large station, this difference in fuel consumption often attains a sizeable figure.

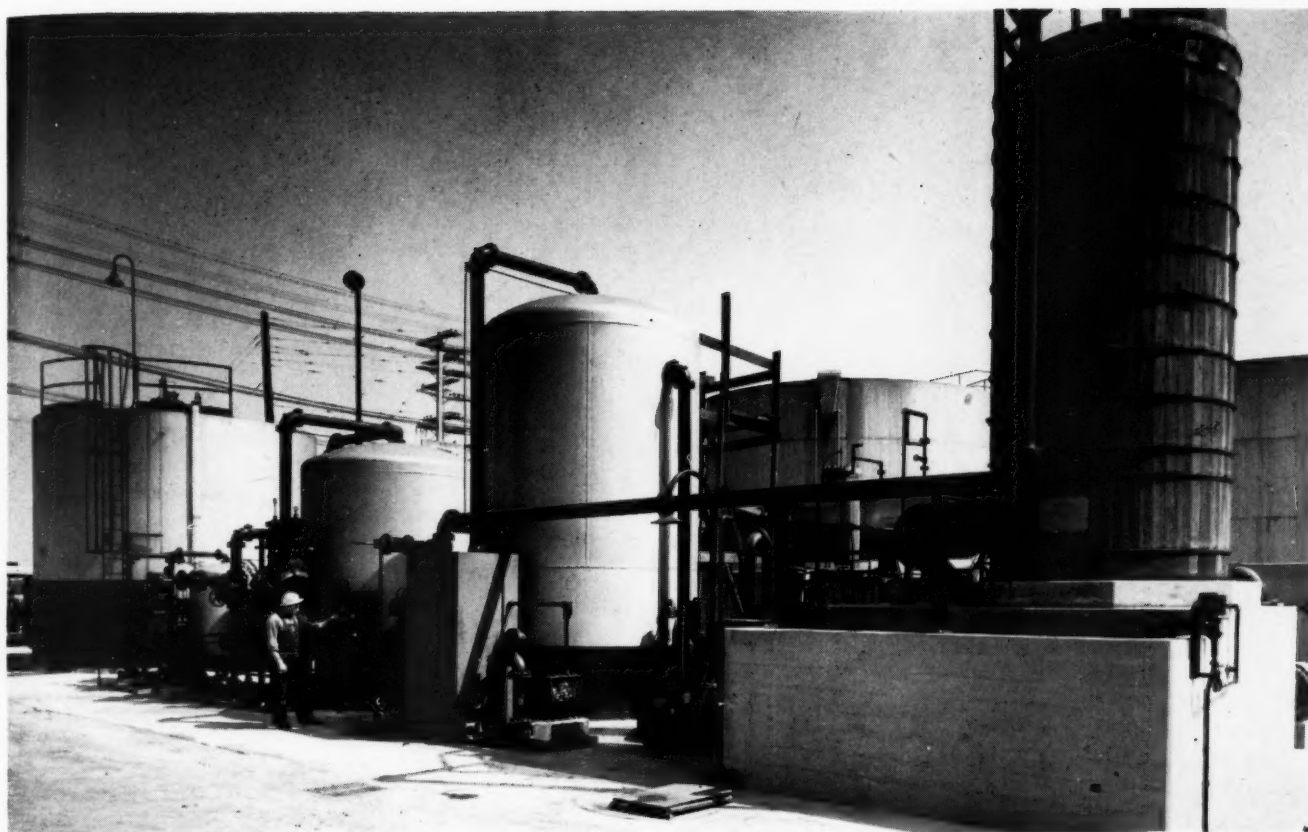
Objections to the demineralizing system are principally from an operation and maintenance point of view. This condition is typical of most developments, and present handicaps undoubtedly will be eliminated soon. In fact, the operating difficulties encountered with some demineralization plants are comparable with those of any other new and different piece of equipment.

At most power plants the operators, after a period of training of a few months, are able to successfully operate new demineralizing equipment. Some items such as controls, instrumentation, and valves require more than normal main-

TABLE 2 — COST COMPARISON

	Evaporator	Demineralizer
Total installed cost	\$125,500	\$45,000
Annual fixed charges at 15 percent	18,800	6,800
Annual chemical cost, 1 percent makeup, 17 gpm	100	1,300
Annual cation and anion exchange material replacement	—	200
Evaluation of space occupied at \$1.15 per cu ft	1,400	600
Total annual cost	\$ 20,300	\$ 8,900
Annual Savings of Demineralizer over Evaporator	—	11,400
Annual fuel savings of demineralizer over evaporator	—	3,600*
Total Annual Operating Savings	—	\$15,000

*At 125,000 kw load with 1 percent makeup when using 13,000 Btu per lb coal at \$8.44 per ton



The Permutit Co.

DEMINERALIZING PLANTS, WIDELY USED IN INDUSTRY, ARE GAINING FAVOR FOR TREATING POWER PLANT MAKEUP.

tenance, and there are some instances of excessive corrosion in pipes and tanks because of improper selection of materials. However, modifications in design are now being made to correct these faults. It is believed that before long demineralizers will be on a par with evaporators insofar as operation and maintenance are concerned.

Economics

Burns and Roe, Inc. recently completed the design and engineering of a 125,000 kw, 2000 psig, 1050/1000 F addition to the Raritan River Plant of the Jersey Central Power and Light Company. Careful consideration was given to the best method of makeup water treatment to be utilized at this station. It was decided that two stage demineralization should be studied as well as evaporation because both methods would meet the rigid requirements of water purity for this unit.

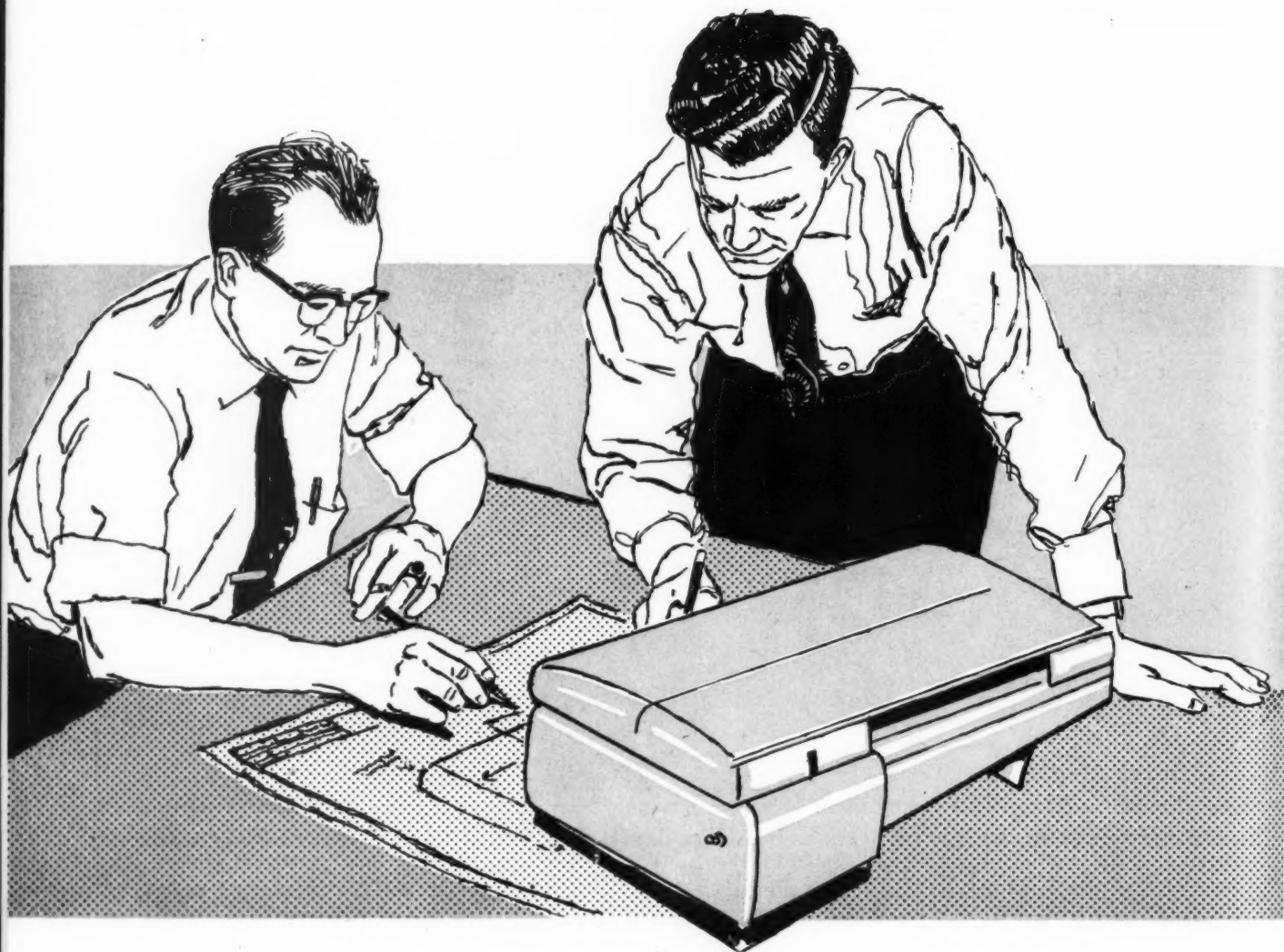
An economic study was carried out to determine which of the methods was more favorable. Table 1 lists the equipment requirements for these two processes, while Table 2 summarizes equipment costs, operating chemical expenses, and an evaluation of the space requirements. The net result, including a reduction in fuel costs, shows an annual saving of \$15,000 in favor of demineralization.

Operating labor and maintenance costs for both methods, according to present information, are expected to be approximately equal. Water purity

is satisfactory as shown by the respective raw water and treated effluent analyses shown in Table 3. Thus, all economic and practical considerations for the units investigated favor the demineralizing plant and justify its selection.

TABLE 3 — ANALYSES WITH DEMINERALIZATION

Cations	Analysis, ppm as	Raw Water	Treated Water
Calcium	CaCO ₃	47	0
Magnesium	CaCO ₃	1	0
Sodium	CaCO ₃	25	0.25
Hydrogen	CaCO ₃	—	—
Total		73	0.25
Anions			
Bicarbonate	CaCO ₃	37	0.25
Carbonate	CaCO ₃	0	0
Hydroxide	CaCO ₃	0	0
Sulfate	CaCO ₃	25	0
Chloride	CaCO ₃	11	0
Total		73	0.25
Total hardness	CaCO ₃	48	0
Methyl orange alkalinity	CaCO ₃	37	1
Iron, total	Fe	0.3	0
Carbon dioxide, free	CO ₂	2.0	0.2
Silica	SiO ₂	4.2	0.05
Turbidity		0	0
Total dissolved solids		90	—
pH		7.55	7.90



The Engineer's Status

In Product Design Organizations

CHARLES H. STANDISH, President
Designers for Industry, Inc.

TODAY A LARGE PORTION of management is acutely aware that engineering is a profession — that it is a pursuit demanding tremendous versatility and a vast amount of functional, constantly accruing knowledge of its practitioners. One of the leaders in this engineering recognition by management has been within the independent product development group of consultants — not drafting firms, but organizations which develop a product from visualization to operational completeness.

At Designers for Industry, for example, we have become cognizant of the fact that the engineer is the most productive single factor in industry in our country. Our future technological progress and liv-

ing standards depend very largely upon the contributions of engineers. If their vision and effort were taken away from the American scene, the result would be that of almost complete immobility.

Our reinterpretation of the importance of the engineering profession has not been caused by any shortage of trained personnel. Its inception began years ago. We have revised our attitude primarily because of the rapidly growing technological prowess which engineers have displayed. We have seen them deliver consistently good work time and again, despite many intricate difficulties and heavy schedule demands. This accumulated respect has led us to delegate engineers with responsibilities once regarded as enormous.

As an immediate consequence, we have seen fit to assign projects of challenging complexity and

depth to product development men. Our work involves almost any conceivable research and development activity commensurate with a 180-man organization — including mechanical, electro-mechanical, electronic, hydraulic, pneumatic, thermodynamic, and instrumentation projects — and our engineers are expected to master and correlate the materials and processes in all of them.

Range of Activities

A multiplicity and variety of jobs, with the consequent and related insights derived from them, makes for increased engineering proficiency. One of our project engineers, for example, has supervised such developments as oil well drilling equipment, continuous coal mining machinery, and oil burners. This diversified experience has given him approaches that will be of considerable value on future projects.

Such an extensive, ever-widening background, based as it is on practical, concrete experience, gives our engineers a feeling of mastery, and it greatly strengthens their general morale and personal confidence. One of the richest rewards of this practice is the feeling of anticipation that the engineer shows towards future projects.

An intimate acquaintance with a variety of projects involves direct and informal contact with experts in each particular branch of engineering. Priceless information is gained in this way — information which would ordinarily be gleaned only by long associations with several different firms.

This exchange and joint analysis of methods and



FREE EXCHANGE OF IDEAS BETWEEN ENGINEERS AND MANAGEMENT CONTRIBUTES TO CREATIVE THINKING.

techniques has been a most happy and productive one. It has served as a stimulus to the younger, less experienced men, and has kept the more mature engineers on their toes.

Method of Operation

It is standard practice in our organization to view the designer and engineer as a creative team, not as two divorced entities. This has resulted in significant and productive achievements. The designer is not relegated to the drafting board, but functions

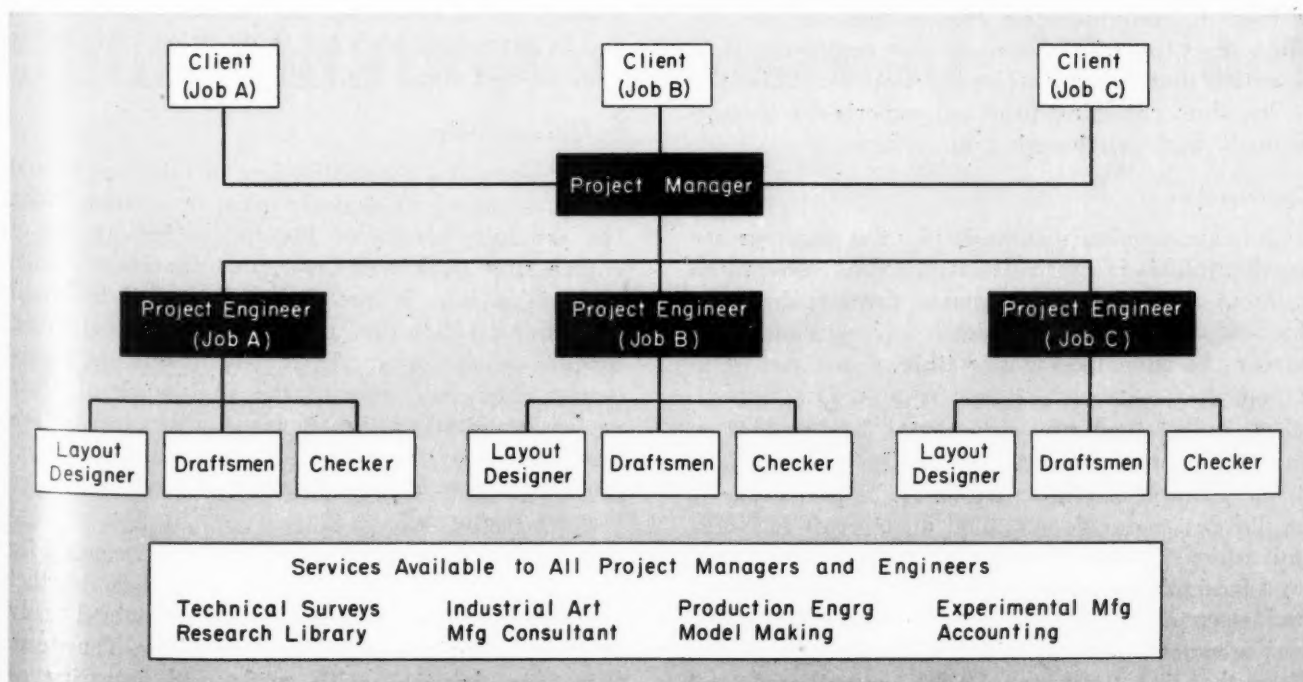


CHART INDICATES THE USUAL ENGINEERING RESPONSIBILITIES WITHIN PRODUCT DEVELOPMENT ORGANIZATIONS.

as the right hand man to the engineer — as advisor, co-worker, and developer of major concepts. This freedom of action is best exemplified through our general project procedure.

Although unforeseen factors may alter any program, our usual method of operation starts with the Project Manager. By consultation with the client, he defines the objectives to be achieved on the engineering project. The Project Manager then turns the project over to a carefully selected Project Engineer, suggesting at the same time the most feasible and desirable methods for solving the problem. The latter analyzes the problem and, with the aid of qualified assistants, makes an exhaustive technical, patent, and market survey.

The Project Engineer then studies the problem and arrives at what he considers the best approach. Informal conferences with his design and development team confirm and elaborate upon his original conception, and the bulk of the design work begins. At any point in this flexibly maintained schedule, any member of the team may freely voice his personal observations and offer solutions.

Design work, in itself, involves a grasp of the interrelationships of movable parts, and sometimes gives to the designer a total operational concept of the product to be fashioned. It is therefore advisable to encourage free expression of ideas, no matter how unusual they may seem at first. This helps to prevent the development of the apathetic attitude of one forever condemned to a singular activity.

Free expression of ideas also serves to give our designers the needed consciousness of contributing appreciably to the final product. And, perhaps most important of all, it strengthens the desire of many of them to continue their studies towards the day when they too will become senior engineers. It is essential that engineers be developed within the ranks, thus obtaining practical experience to supplement basic engineering know-how.

Opportunities

The chances of advancement for the engineer are excellent. This is especially true today, since management of product development firms realize that the best of the future top-notch technical men will have to be developed from within.

Typical of this procedure is the story of an engineer who joined our organization late in 1942 as an aircraft loftsmen. In April, 1943, he was advanced to the position of Senior Designer. In that capacity he did design-development on an aircraft field-test unit which involved mechanics and hydraulics, and on a facsimile machine which embraced mechanical and electrical engineering. In the fall of 1945 he was advanced to the position of Project Engineer. From that time until early 1949 he contributed most of his creative thought toward the design and development of a 16 millimeter sound projector, a

portable electric saw, a coke stoker, and several other diversified projects.

In early 1949 he was named a Senior Project Engineer, and in the summer of 1950 was promoted to Assistant Project Manager. This placed upon him a major share of the responsibility for all projects in our Commercial Development Division, and established him as a chief adviser and consultant to the Project Manager. The picture is one of continuous progress and development.

Broad Experience

Work of this nature involves some contact with executives in the departments of sales, engineering, manufacturing, methods, tooling, and executive management. The factors of cost and saleability of a product constantly influence design and development. Conferences with sales personnel are a must in order to avoid overlooking sales considerations.

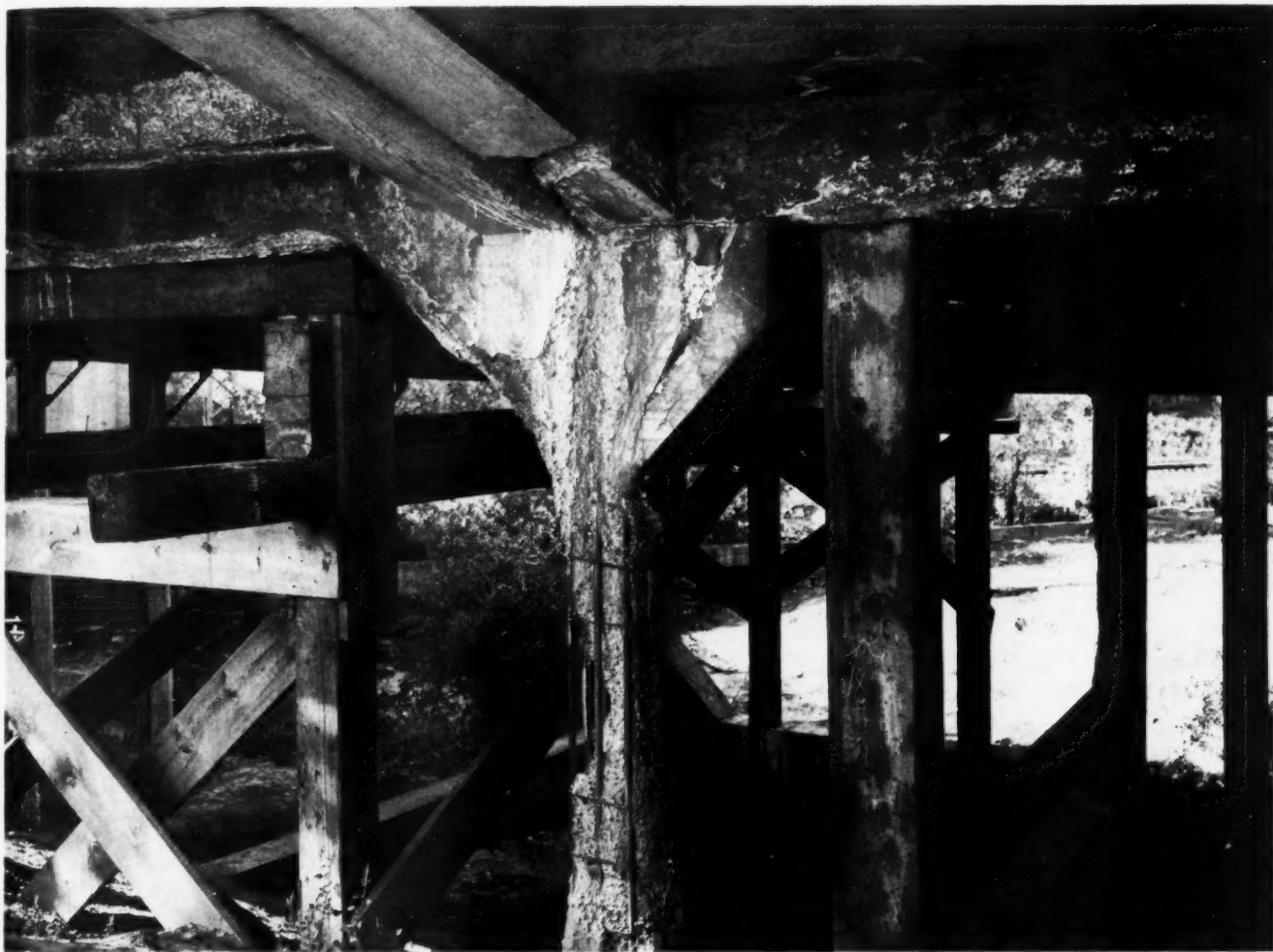
Contacts with production engineers can be invaluable. From them, the resourceful engineer can obtain useful information about the various plant systems — knowledge that would otherwise take many years to acquire. This facet is of considerable value to those who are looking forward to a position in management.

Perhaps the two most important qualities demanded of a product development engineer are creativeness and originality. Clients bring their problems to consultants dealing with product development primarily because they want a fresh point of view and an attitude not cluttered with the extended tradition and confining limitations of their particular concerns. They want ingenuity above all else. A good engineer revels in this set of circumstances. He is elated by the challenge it involves, and he is charged with a determination to do better than anyone else.

Professional Status

Engineers in a consulting firm of this type should not be assigned to clerical, sales, or routine tasks. We are fully aware of the innate importance of engineering work and we do not, therefore, assign a specialist who is qualified for detailed technical work to a position that some non-professional might handle satisfactorily. As a result, our engineers devote their full time to the real work of their profession. Product development organizations are centered entirely around engineering, and it is upon the delivery or lack of delivery of this one service that we rise or fall.

Engineers naturally appreciate this aspect, for they know beyond any question of a doubt that they were hired and are being retained only because of their engineering know-how. They can, therefore, function with pride and integrity as practitioners of a profession, with the satisfaction that a consistently professional job brings.



CLOSEUP OF CRUMBLING CONCRETE COLUMN, SHOWING EXPOSED REINFORCING STEEL AND HONEYCOMBED CONCRETE.

Rehabilitating a Concrete Viaduct

JOSEPH G. CONRATH
Consulting Engineer

MODERN GROUTING TECHNIQUES, used to rehabilitate a condemned viaduct in Erie, Pennsylvania, permitted reopening of a vital east-west artery in much less time than would have been required to construct a new bridge. The structure, built in 1925, had been allowed to deteriorate until, in May, 1952, it was declared unsafe for use.

Considerable concrete had been broken away, and visual inspection showed a honeycomb effect in much of the exposed interior concrete construction. Pillars were cracked, and reinforcing and girder steel were badly rusted and exposed. Failure of the deck (which was badly cracked) and water en-

tering other parts of the bridge, had badly deteriorated the structure and had made it unsafe for use by today's heavy, fast traffic.

The viaduct measures approximately 400 feet long and has a total width of 50 feet. It curves sharply over a creek and railroad tracks. Although it is located on a state highway, jurisdiction of the bridge was given to the City of Erie in 1950.

Engineering Considerations

As a consulting engineer, we were called in and told of plans for a Public Utilities Commission hearing and were asked to prepare plans either for rehabilitation of the viaduct or for a completely new structure.

Plans for a modern \$300,000 four-lane viaduct over a new, curve-reducing route, with provisions



VIEW OF CONDEMNED VIADUCT, DECLARED UNSAFE EVEN AFTER TEMPORARY SHORING (RIGHT CENTER) WAS PLACED.

for future extensions and approaches, were considered. An alternative, using only the existing span over the railroad also was considered. This involved a considerable amount of fill and a culvert.

However, because of the need to reopen the viaduct to traffic as quickly as possible, it was decided to rehabilitate the old structure. Various plans for restoring and strengthening the bridge were studied. A grouting technique, the Prepakt Concrete method, was decided upon. This method uses a coarse aggregate and Intrusion mortar.

Grout and Aggregate

Prepakt coarse aggregate may be either gravel or crushed rock. To provide passages for proper flow and distribution of the Intrusion mortar, the minimum size of the aggregate is limited to $\frac{1}{2}$ or $\frac{3}{4}$

inch. The maximum size is determined by spacing of reinforcement and forms, and by the size which is economically available and easiest to handle.

After the coarse aggregate is placed in the forms, the Intrusion mortar is pumped into the voids either through the forms or through pipes placed within the aggregate. This mortar is made up of portland cement, sand, water, Alfesil, and Intrusion Aid. Alfesil is the trade name for a finely divided siliceous material which replaces from 30 to 50 percent of the cement that would otherwise be required and which reacts with the lime, liberated by the cement during setting, to form insoluble strength-producing compounds.

The lime-Alfesil reaction also greatly reduces permeability. The Alfesil particles separate the cement grains in the fluid mortar, delaying initial set,



WORKMEN ARE BUILDING FORMS TO HOLD AGGREGATE, GROUT, AND IN SOME INSTANCES, NEW CONCRETE.



NEW ROW OF COLUMNS, INSERTED UNDER THE CENTRAL PART OF THE VIADUCT TO INCREASE LOAD CAPACITY.

and are spherical to improve flow characteristics.

Intrusion Aid, in very small quantities, gives mortar properties of colloidal suspension. It eliminates effects of settling and setting shrinkage; lowers water requirement; delays early stiffening; and, in hardened concrete, provides the weather-resisting characteristics of the best air-entrained conventional concrete.

Intrusion mortar also is widely used as a grout for tightening, consolidating, and shutting off the flow of water in highly porous and cavernous material under dams and structures, and behind tunnel linings. Without sand, the highly fluid grout is used in hard rock for consolidation and stopping water flows, and in cracked concrete structures to restore them to their original sound condition.

It was decided that this method would unconditionally put the viaduct in first class shape, with an idea of future load requirements (up to 20 tons), and would make the bridge better than when originally finished in 1925.

We recommended the use of this method and were immediately requested to prepare suitable plans for repairing the viaduct. The Prepakt Concrete Company of Cleveland was awarded the rehabilitation work on the bridge under a unit price basis involving some twenty construction items. Total cost was estimated to be \$140,000.

Repairs

Comprehensive data tabulation sheets were prepared to show the construction of the bridge and exactly what repairs would be needed.

It was found that the expansion bearing ends of the girders, in some instances, had been prohibited from working because of interference from wooden



EQUIPMENT FOR PREPARING AND PUMPING INTRUSION MORTAR IS RELATIVELY SMALL AND EASILY SET UP.

blocks between girder ends and concrete, and water entrance had rusted the rollers. Expansion was forced across the bridge against the concrete columns, which were in the state of collapse. An entirely new row of columns were inserted under the central part of the bridge to increase load capacity for modern traffic. Because of space limitations, grouted aggregate was used for the piles.

The original road bed consisted of a three-inch asphalt coating on coarse two-inch concrete, which was badly deteriorated. This was removed, down to sound concrete on the deck, and was replaced with a 12-inch concrete slab, Class A, and covered with a one-inch asphalt surfacing—a positive seal against former troubles. All expansion bearing plates and roadway expansion joints were replaced.

It was found that black dirt had been used as part of the form when pouring the west wall end of the bridge, thus inducing honeycombing of the concrete. The repair on this involved constructing practically a new wall. Four extra long columns at one end of the viaduct, where most of the thrust bears from curbing and from the girders in expansion and contraction, were found to be badly deteriorated. These were put in the best condition possible and were enclosed in six-inch concrete casings, thus increasing their size from 18 inches square to 30 inches square.

Exterior girders were reinforced by adding extra haunches in eight locations to provide increased capacity.

Work on the project was pressed on a two-shift basis, since speed of job completion was an important factor. The City of Erie now has a viaduct which not only has been restored, but has been strengthened to meet increasing traffic conditions.



WORKMEN PUMPING INTRUSION MORTAR INTO FORMS FILLED WITH SPECIALLY GRADED, COARSE AGGREGATE.



The Pittsburgh Offer

Staff Report

Pittsburgh offers the Engineering Societies an attractive Headquarters location plus a million dollars.

HAVING OUTGROWN the space available in their office building at 29 West 39th Street, in New York City, the Founder Societies and other leading technical groups are looking for a location for a new Engineering Center building. Last month CONSULTING ENGINEER reported on the Chicago Offer—the proposal being advanced by engineers and educators in Chicago to encourage the Societies to locate in their city.

Pittsburgh is also promoting the idea of a move from New York City, and engineering and civic leaders have published brochures and conducted tours for members of United Engineering Trustees and other interested parties. A lot of work has gone into the campaign presenting Pittsburgh as the logical location for a new Engineering Center building,

and a lot of money is available to make the invitation attractive.

A million dollars—perhaps more—is waiting for the Societies if they will select Pittsburgh for their site. This money would be available in cash and could be used to cover a portion of the cost of the new building. As to the actual location within the city, this would be up to the Societies, themselves. There are at least three possible choices: Point Park area, Lower Hill Development, and the University Center area. Each has its advantages.

The Point Park and Gateway Development is at the tip of the Golden Triangle. The 36-acre park cost \$7.5 million. In this area a model business development is being built by Equitable Life. Already three new skyscrapers, in park-like surroundings, house some of the nation's major corporations. Equitable has invested \$43 million in the area and plans further development. An excellent site facing Point Park could be made available for an Engineering Center.

The Lower Hill Development consists of 105 acres just east of the Triangle. It is to be developed



ARCHITECTURAL DESIGN SUGGESTED FOR A SOCIETY HEADQUARTERS BUILDING IN THE GOLDEN TRIANGLE.

into a new cultural, business, and residential center. For example, an \$8 million all-weather auditorium with retractable roof is to be built. This will provide plenty of exhibit space for shows and will seat 16,750 at conventions. This would make an attractive location for an Engineering Center.

Then there is the University Center area, which in many respects resembles the Technology Center location being offered by Chicago. This area is located about two miles from the Golden Triangle, and is the core of Pittsburgh's educational, medical, cultural, and sports activities. Three engineering colleges — Carnegie Tech, University of Pittsburgh, and Duquesne University — are in this area. The area also includes the Cathedral of Learning, two large hotels, Mellon Institute, and Carnegie Library.

The downtown location would be the most expensive, the Lower Hill Development would be less expensive so far as land is concerned, and it is likely that land might be made available in University area at no cost to the Societies. Also, building costs in the University center would be lower because a skyscraper type building would not be required; costs of construction would be comparable to building on the land offered by Illinois Tech. in Chicago for the same type of building. Depending upon the site selected and considering the gift

offered by Pittsburgh, the Societies could realize a substantial savings over housing facilities in Manhattan, the present location of the Society Headquarters building.

Central Location

It is estimated that about three-fourths of the nation's engineers live in the parallelogram formed by drawing lines to connect the cities of Chicago, Boston, Washington, and St. Louis. Pittsburgh is very close to the geographical center of this area. While this does not take into consideration the growing importance of the West as an engineering area, there is no question but that the majority of the governing bodies of the Societies, who must meet frequently on Society business, are located in this parallelogram.

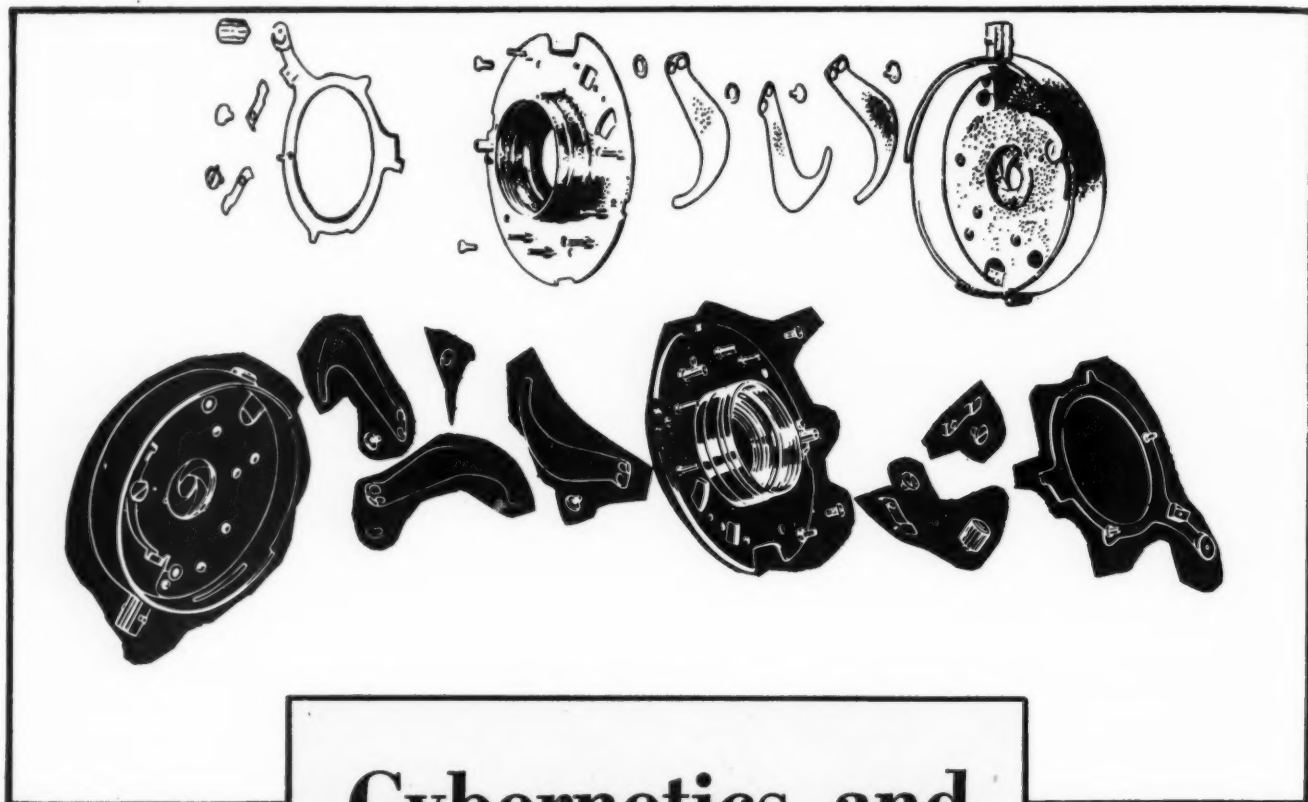
In comparison with Chicago, Pittsburgh comes out second best as a transportation center (as does every other city in the country) but improvements are being made to overcome some of Pittsburgh's handicaps. No longer will the visitor have to curse the long trip to the airport, for a new four-lane highway makes the trip only twenty minutes from the hotels and the center of town. Six airlines bring 111 flights to Pittsburgh daily, and five other airlines have applied to serve the city with 54 additional flights. Three railroads serve Pittsburgh with 158 passenger trains daily, and a number of new turnpikes make access by highway relatively easy.

Visitors to Pittsburgh — especially those who have not been there for several years — cannot but be impressed by the changes in the city. No longer can "Pittsburgh" be used as a synonym for smoke and smog. During the past seven years of smoke control, the hours of heavy smoke have been reduced 93 percent, and the city is receiving 69 percent more sunshine than six years ago. In fact, Pittsburgh may now list itself among those cities freest from air pollution.

Diversified Interest

Contrary to general belief, Pittsburgh is not a city controlled by a few great industrial interests. The 375,000 industrial employees in the city work for 3000 manufacturing plants and produce \$5 billion worth of 6500 different manufactured products, exceeding in value the product of each of 37 states. The area is, however, the home of the world's largest producers of steel, tin plate, aluminum, glass, safety equipment, air brakes, and refractories.

Pittsburgh does have much to offer in addition to the \$1 million which is being collected as a gift to the Societies. As the Special Committee puts it, "For all these reasons — choice sites, dollar savings, handy transportation, good living conditions—Pittsburgh offers a unique opportunity for the technical societies to make their new home part of the rebirth of a great city with the backing of the business leaders of the community."



Cybernetics and Product Design



EDWARD A. MAHONEY, Staff Engineer

KENDRICK PORTER, Vice President



**Lester B. Knight & Associates
Consulting Engineers**

Edward A. Mahoney acquired first-hand experience with management problems—as a staff engineer with Cresap, McCormick & Paget and as senior engineer with the W. L. Maxon Corp. He holds a CE degree and also an M.S. in Industrial Engineering from Columbia University.

Kendrick Porter rose from staff engineer to partner in his ten years with Booz, Allen & Hamilton. Now heading N.Y. operations of Knight & Assoc., he is well-known for his applications of higher mathematical techniques to simplify and expedite the solution of industrial problems.

Cybernetics is the science of mechanical-electrical control and communications in machines and man. When applied to product design, it gives industry new cost reduction techniques.

THE CYBERNETICS APPROACH, as used here, is the planning and control over product design by use of the same techniques that prevail in the broad field of cybernetics. One of the most useful of these techniques, and one that is being successfully applied in several industrial enterprises, is linear programming; sometimes known as input-output analysis. This technique concerns itself with the problem of planning a complex of interdepend-

ent activities in the most optimum manner.

A classical engineering problem is to determine the size of a cylinder that holds exactly one quart of liquid and uses the least amount of a given piece of sheet metal. Linear programming facilitates solving this same kind of problem when the number of interdependent variables is large and therefore may be difficult to deal with by other mathematical techniques. It is being used for such purposes as scheduling of production through machines, blending of gasolines, and aircraft design planning. One of the most significant opportunities for its application is in the engineering design of assembled products and their component parts. These opportunities offer potential benefits to a wide segment of industry, especially in those plants where mass production has, up to now, appeared to be impractical and uneconomical.

Example

Five years ago a New England company set out to reduce its manufacturing costs. This company produced about 300 industrial products. Each product contained between 25 and 60 different component part designs and more than 12,000 different part designs were used for all products.

Within a year, the total number of different part designs needed for the 300 products was reduced to 7000. Continuous production methods were found to be feasible for 5,000 of these. Such methods led to sharp reductions in inventory. They lessened, by more than half, the volume of work required to design, schedule, tool, handle, and fabricate the parts. While the costs of most products were decreased, the cost of a few were increased. However, the total of all manufacturing costs dropped so much that the profits of the company are several times greater than before the project was started. This has happened despite a 40 percent increase in hourly labor rates and a 60 percent increase in material prices.

These results were achieved by:

1. Seeking lower aggregate manufacturing cost through maximum use of mass production techniques;
2. Effecting mass production techniques through greater interchangeability of parts with larger volumes of fewer parts being produced;
3. Obtaining greater interchangeability of parts through a cybernetic approach to product design.

Lowest Aggregate Manufacturing Cost

The ultimate objective of any manufacturing enterprise should be to obtain the lowest cost for all of its production in aggregate. This is quite different from obtaining the lowest cost for each item in the catalogue, with each being treated as a distinct product. The statement may appear obvious, but lowest aggregate cost does not directly control

product design and manufacture in most companies.

For example, assume that the following conditions prevail within a specific company:

10,000 units of product "A" are manufactured each year at a unit cost of \$10 and a total cost of \$100,000.

5,000 units of product "B" are manufactured annually at a unit cost of \$20 and a total cost of \$100,000.

In most situations, ways will be sought to reduce the costs of each product individually. Thus, a change in the design of a component of product "A" that may reduce its cost of manufacture will be investigated. The substitution of a cheaper material for some component of "B" may be tested. This product-by-product approach to cost reduction is aggressively prosecuted by many companies and has led to very substantial benefits. Often, too, it has led to excessive numbers of different part designs with resulting excessive service, material, and other costs of manufacture.

In the case cited, there may also be an alternative opportunity to decrease manufacturing cost in aggregate by considering both "A" and "B" together. This may involve the substitution in both products of a new component which is mass produced and which may increase the unit cost of "A" by \$.50 while it decreases that of "B" by \$7.00, for an annual aggregate reduction of \$30,000.

Industrial companies have innumerable cost reduction opportunities like this, the majority of which are not recognized. Yet, when these have been wisely and energetically sought, they have made a much greater contribution to lower aggregate manufacturing cost than have product-by-product reductions.

TABLE 1—COMPARISON OF LOWEST COSTS FOR EACH PRODUCT WITH LOWEST AGGREGATE COST

A. Each product made at lowest cost attainable independent of other products:

Annual Units Produced	Cost Per Unit	Total Cost
100,000	\$20	\$200,000
300,000	10	300,000
		\$500,000

B. All products made to attain lowest aggregate costs:

Annual Units Produced	Cost Per Unit	Total Cost
100,000	\$13.50	\$135,000
300,000	10.20	306,000
		\$441,000

	Type	Desk						Wall						Pedestal			
		A		B		C		D		E		F		G		H	
		7"		9"		11"		12"		15"		18"		22"		26"	
Function	Sub-Assembly & Components	Part No.	Quantity	Part No.	Quantity	Part No.	Quantity	Part No.	Quantity	Part No.	Quantity	Part No.	Quantity	Part No.	Quantity	Part No.	Quantity
Supporting Structure	Base:																
	Stand	PX-11	1	PX-15	1	PX-17	1	CX-52	1	CX-52	1	CX-14	1	BX-6	1	BX-8	1
	Casting	4030	1	4018	1	4018	1	4671	1	4671	1	320	1	8314	1	8817	1
	Post													67	1	169	1
	Felt	F 1	1	F 2	1	F 4	1	F 6	1	F 8	1	F 12	1				
Power	Switch	S 42	1	S 42	1	S 42	1	S 83	1	S 83	1	S 83	1				
	Motor & Housing:																
	Motor	1327	1	1156	1	1573	1	1981	1	1901	1	2100	1	8088	1	8090	1
	Handle					14	1	21	1	38	1	44	1				
	Oscil. Housing	O 8	1	O 10	1	O 12	1	O 71	1	O 75	1	O 63	1	O 101	1	O 170	1
Power Transmission	Wing Nut	W 4	1	W 6	1	W 12	1	W 21	1	W 5	1	W 18	1	W 27	1	W 36	1
	Switch													S 21	1	S 21	1
	Arbor Assembly:																
	Hub	H 180	1	H 187	1	H 193	1	H 200	1	H 206	1	H 241	1	H 283	1	H 291	1
	Housing																
Impeller	Screws	1/4-28	2	1/4-28	2	5/16-24	2	3/8-24	3	3/8-24	3	3/8-24	3	7/16-20	3	7/16-20	3
	Blade Assembly:																
	Blade	B 7	4	B 9	4	B 11	4	B 12	4	B 15	4	B 18	4	B 22	4	B 26	4
	Rivets	13 1/2	3	13 1/2	3	12	3	11	3	9	3	8	3	4 3/4	4	3	4
	Safety Cage:																
Guard	Cage	C 7	1	C 9	1	C 11	1	C 12	1	C 15	1	C 18	1	C 22	1	C 26	1
	Ferrule	T 7	1	T 9	1	T 11	1	T 12	1	T 15	1	T 18	1	T 22	1	T 26	1
	Name Plate	717	1	717	1	717	1	82	1	82	1	82	1	177	1	177	1

A FUNCTIONAL CHART, SHOWING THE COMPONENTS FOR ELECTRIC FANS, ILLUSTRATES ONE STEP IN DETERMINING INCREASED INTERCHANGEABILITY OF PARTS THROUGH THE APPLICATION OF CYBERNETICS TO PRODUCT DESIGN.

Mass production is the system that has been developed for manufacturing discrete units of products at the lowest aggregate cost. It is practically characterized by interchangeable materials and parts passing in a thin continuous flow from vendors through a series of work stations to a completed component of assembly. The rate of flow must be sufficient, but not more than sufficient, to keep each station in continuous operation.

Mass Production

Mass production usually involves large volume, large investment in equipment, and is almost always thought of in terms of assembly. These features have given rise to many warnings of caution in its use, especially from those who are not associated with mass production enterprises. However, large volume and large investment are relative matters; and mass production can be and is applied equally well to the manufacture either of components or of assemblies. And components thus produced may be assembled by mass or batch production techniques into one, five, or 500,000 units of standard or specialty products.

It is not apposite to describe in detail the kinds of cost reduction that can occur when fabricating, assembly, or both, are changed from a batch or job to a mass production basis. However, it is significant

that the benefits are brought about just as much, or more, through the application of very different concepts to such activities as design, purchasing, planning, scheduling, inventory control, and inspection, as well as through the more obvious means such as reduced set-up time and less materials handling.

Interchangeable Parts

Eli Whitney, in 1798, demonstrated that the design and manufactured cost of interchangeable parts would facilitate low cost production of an army musket. Slightly more than 100 years later, Henry Ford made spectacular advances in manufacturing economies based on Whitney's concept of interchangeability of parts with respect to a single end product. This is a one dimensional concept of interchangeability and is suited for application only to a limited number of manufacturing enterprises.

Two Dimensional Interchangeability

The largest number by far of modern industrial companies produce many different sizes and styles of products in several different product lines. While some of these companies have expanded from one original product, the typical situation today is widely varying volumes of diverse, but related products. This condition indicates the need for a concept that leads to interchangeability of component parts, with-

out selective fitting and trimming, among as many different end products as may be economically feasible.

Automobile manufacturers have applied this concept for many years. They use the same wheels, gears, and axles on convertibles and coupes, on lower priced cars and on higher priced cars. The same body stamping is used on different makes of cars. The Swiss watch industry carries this concept much further. In this industry, many of the component parts are fully interchangeable among the products of many competing companies.

Actual Practice

However, the majority of industrial concerns limit this concept, if they apply it at all, primarily to a few standard fittings such as bolts, nuts, and washers; or to the specifications, but seldom to the sizes, of some raw materials. The majority of their parts are restricted to interchangeability within one product, or at most, to a few sizes of one type of product. That is, each product is designed originally "to stand on its own feet". This concept of product design is carried over to manufacturing. There, at all stages of production, the differences among finished products and among their component parts are over-emphasized; the actual or potential uniformity of products and parts is under-emphasized.

Translated into volume of work in the example given, it means that individual time and attention formerly were given to designs, prints, tools, jigs,

fixtures, inventories, manufacturing methods, labor standards, raw material specifications and usages, machine set-ups, cost estimates and analyses, purchase orders, shop orders, and inspection for over 12,000 instead of 7,000 different part designs.

Even in some companies where product designs are developed with a view that is directed toward reducing the number of different designs of component parts, this viewpoint may not be transmitted adequately to manufacturing personnel, with the result that the potential manufacturing benefits are lost.

For example, the catalogue of an industrial pump company describes several hundred standard pumps. The company also produces hundreds of specially designed pumps. Customer orders usually call for between one and one hundred units of a particular catalogue number. At any time, the factory is normally engaged in manufacturing about 75 different products and their components, with the volume too small to suggest, even remotely, the desirability of mass assembly.

Potential Interchangeability

The component parts of the pumps are designed to highly standardized engineering specifications. A recent analysis of production showed that 65 percent of the different parts made over the past few years were potentially interchangeable among not less than 35 percent of the finished units that were turned out. For some parts, this interchangeability amount-

C _j		0										.68	.43	.10	1.71	.05	.83	.07	.45	.88	1.51	2.11
		P ₀	P ₁₂	P ₁₃	P ₁₄	P ₁₅	P ₁₆	P ₁₇	P ₁₈	P ₁₉	P ₂₀	P ₁	P ₂	P ₃	P ₄	P ₅	P ₆	P ₇	P ₈	P ₉	P ₁₀	P ₁₁
0	P ₁₂	0	1									.311	1.61	.311	.47							
0	P ₁₃	0		1										.032	.064	.051	.087					
0	P ₁₄	0			1												.880	.141	.687	.321		
0	P ₁₅	0				1											1.11	1.29	1.31	4.11		
0	P ₁₆	0					1												.545	.355	.154	.761
0	P ₁₇	78						1				1		1			1		1			
0	P ₁₈	141							1				1		1			1		1		
0	P ₁₉	129								1				1		1					1	
0	P ₂₀	221									1				1		1			1		1
Z _j																						
Z _j -C _j												-.68	-.43	-.10	-1.71	-.05	-.83	-.07	-.43	-.88	-1.51	-2.11

THE ABOVE TABLEAUX OR "MODEL" IS DEvised FROM THE SIGNIFICANT PARAMETERS INFLUENCING COST AND SOLVED TO DETERMINE THE MIX OF COMPONENT PARTS THAT WILL RESULT IN LOWEST AGGREGATE (OR OPTIMAL) MANUFACTURING COST. A COMPLETE EXPLANATION WILL REQUIRE FURTHER STUDY OF REFERENCES (4) AND (5).

ed to over 70 percent of the total output of pumps.

However, each size and type of pump had been produced as a separate and distinct product through all stages of manufacture for many years. Further analysis led to the conclusion that 70 percent of parts should be mass produced and all assembly should remain on a batch basis. This has led to a 34 percent reduction in aggregate manufacturing costs.

Thus, it is seen that application of a two dimensional concept of interchangeability of parts leads to fewer part designs. It follows that fewer parts will be produced in larger volume. Therefore, the greater the extent to which the number of different part designs can be reduced, the greater will be the opportunities to produce these by mass techniques.

Methods

Methods or techniques for determining how increased interchangeability of parts can be obtained through the successful application of cybernetics to product design include such steps as:

1. The desirable performance and appearance characteristic and function of each finished product involved are fully defined.

2. The desirable performance and appearance characteristics and functions of each component part as required to provide the desired attributes in each finished product are defined.

3. A chart is devised showing in an orderly and logical arrangement the different finished products and the necessary attributes of the components of these products and identifying the specific parts that are used to supply each attribute to each product.

4. This chart also provides space for listing parts that are extraneous or non-contributory to the necessary attributes of components.

5. This chart is an excellent tool to provide an over-all grasp of the problem. Also, it points up inconsistencies that currently prevail in the application of components to products. It establishes a "common sense" background to aid in avoiding errors and trivial matters in the subsequent steps of the project.

6. The total manufacturing cost that can be allocated properly to each component part at varying volumes of production of the part is calculated. This cost includes all matters from ordering of raw material through assembly into a finished product. The interrelationship between cost, quantity produced, and other influences is determined for each part.

7. A series of tableaux or a "model" is devised for arranging the data developed in (6) into a useful operating tool. The most significant parameters influencing cost are identified and used as a framework for construction of the model.

8. The model is solved to determine the mix of component parts that will result in lowest aggregate (or optimal) manufacturing cost. This mix

represents the optimal product designs. In arriving at this solution, it will be found that increased interchangeability of parts will decrease aggregate manufacturing cost until an optimal point is reached. Thereafter this cost will increase.

Cost Reduction

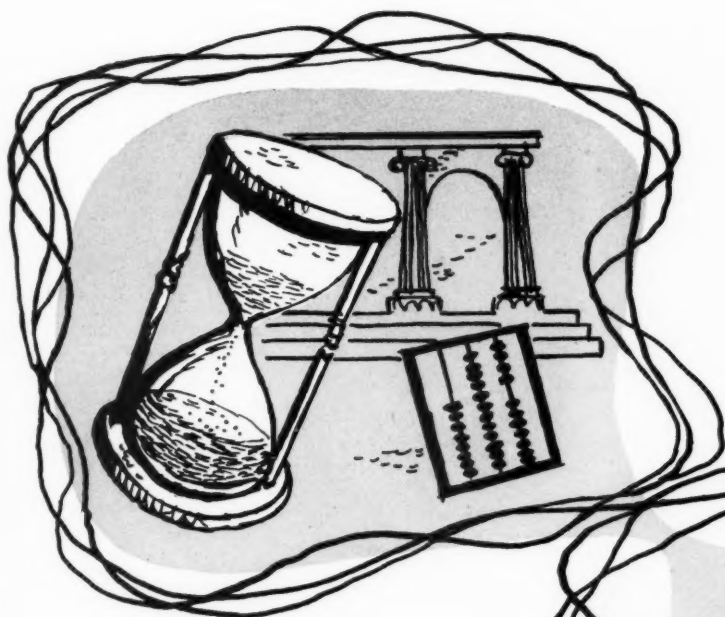
When the optimal product designs are determined, the optimal manufacturing cost can be calculated readily and compared with the present aggregate cost in order to learn the amount of potential cost reduction. Following this, the specific steps required to move from the present to the optimal condition should be established and the cost, timing, sequence, and advisability of taking these steps decided. The effectiveness of the cost reduction program will be measured by the change that actually takes place in aggregate manufacturing cost.

This approach through product design, along with research operations, and automation, offers potential benefits to a wide segment of American industry. These opportunities are recognized by the few companies that have started similar projects in recent years. As indicated in the references, the oil industry has used phases of cybernetics to help program its interdependent activities; the airplane industry in its aircraft design planning; and manufacturers for scheduling of production through machines. The methods for determining how increased interchangeability of parts can be obtained, and how far it can be extended over the entire output of an industrial enterprise, will continue to be more broadly applied.

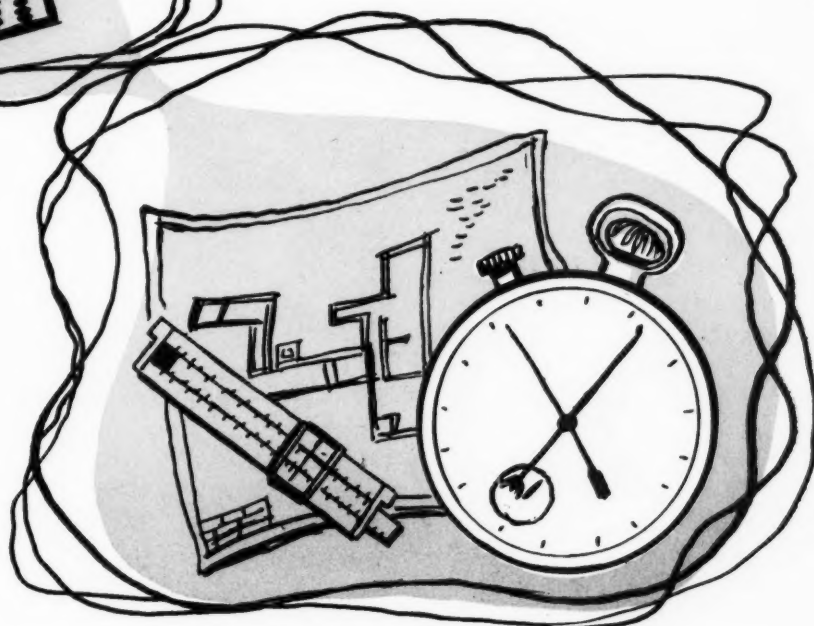
Perhaps one of the most important aspects of the cybernetic approach to product design, in this day of rapid advances in use of new materials and of increasing complexity in product designs, is that it provides a key to simplification of these designs. This simplification will undoubtedly be one of the first steps in developing automatic factories.

REFERENCES

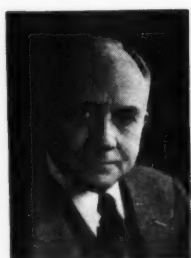
- (1) Peter Drucker. The authors wish to make a special acknowledgment to Mr. Drucker for the privilege of reading part of the manuscript of his book, "The Practice of Management", to be published by Harpers in the summer of 1954.
- (2) Leland A. Bryant, "The Assembly Problem", *Consulting Engineer*; Vol. 2 Number 8, October, 1953.
- (3) Norbert Wiener, *Cybernetics, or Control and Communication in the Animal and the Machine*; Technology Press, Cambridge, 1949.
- (4) A. Charnes, W. W. Cooper and A. Henderson, *An Introduction To Linear Programming*; Wiley, New York, 1953.
- (5) A. Charnes, W. W. Cooper, Donald Farr et alii, "Linear Programming and Profit Preference Scheduling for a Manufacturing Firm", *Journal of the Operations Research Society of America*; Vol. 1, Number 3, May 1953.
- (6) A. Charnes, W. W. Cooper and B. Mellon, "Blending Aviation Gasolines—A Study in Programming Interdependent Activities in an Integrated Oil Company", *Econometrica*; XX, 2.
- (7) Robert A. Bailey, "Application of Operation Research Techniques to Airborne Weapons System Planning", *Journal of the Operations Research Society of America*; Vol. 1, Number 4, August 1953.
- (8) John Diebold, *Automation, The Advent of the Automatic Factory*; D. Van Nostrand, New York, 1953.



The Place of Management Engineering



A concise rundown of the management consultants' operating areas of interest to consulting engineers.



Mr. Farwell has been active in the field of management engineering since January, 1917. He has been president of Business Research Corporation since 1924; he joined the predecessor firm in April of 1920. He was awarded a Ph.D. in electrical engineering with a minor in economics from the University of Illinois in 1914. During his career, he has amassed wide experience in the application of

STANLEY P. FARWELL

President

Business Research Corporation

business management principles to increase efficiency of operation in industrial concerns, public utilities, associations, hospitals, social service organizations and governmental bodies. Mr. Farwell has served many agencies of federal and state governments as well as many professional and civic associations. He has been a director and vp of the American Management Association and the Association of Consulting Management Engineers.

MANAGEMENT ENGINEERS, either in a resident or consulting capacity, have considerable influence in planning the most effective use of men, methods, machines, materials, and money required to produce, operate, or market the material things which play a large part in our economy. They do not design, construct, or operate any of the engineering adjuncts of modern civilization.

In response to a well-defined need, modern industrial engineering—the forerunner of management engineering—found a specialized niche for itself about fifty years ago. The first industrial engineer ever known to history was the Babylonian king, Hammurabi, who reigned from 2285 to 2231 B.C. He developed the first known minimum wage, first production control, first planning methods, first

ANALYSIS OF SERVICES OFFERED BY 39 MEMBERS MANAGEMENT ENGINEERS AS PRESENTED IN THE ASSOCIATION

General Problems		Totals		
Organization and reorganization	31		Materials handling	20
Operating policies, programs, controls	31		Processing methods	18
Reports for executive control	25		Time and motion studies	13
Reports for executive guidance	20		Quality control	13
Expansion and diversification	17		Scheduling and dispatching	12
Executive compensation and incentives	16		Work simplification	9
Economic studies and forecasts	12		Procurement	6
Manualization of executive functions	9		Maintenance studies	4
Recruitment of executive personnel	5		Cost reduction programs	4
Management audits	5		Safety programs	3
Actual management of a business	5			
Professional directorships	3			
			Office Problems	
			Systems and procedures	17
			Building and office layout	14
			Selection of office equipment	9
			Incentives	6
			Time studies and standards	4
			Job simplification	3
			Office services	1
Production Problems				
Plant facilities and layout	28			
Production and inventory control	24			
Incentive plans	21			

accounting system, first use of vouchers, and the first declaration of relations between labor and employer.

His planning department for the execution of royal orders always definitely and laconically specified the number of men and days required to perform an allotted task. This is shown by the extract:

This work is not too much for the men with you. When thou shalt see this better, with the strength of men which are with you, within three days clear out the canal within Crech. After cleaning the canal do then the work regarding which I wrote you.

This 50-word order specifies the time to start the job, the standard time for the job, and the job itself, as well as the future designation of work.

Biblical Engineer

It is a strange fact that while management engineering is a late specialization, one of the earliest engineers in recorded history was a management engineer. His story is mentioned in the foreword to the Controllership Foundation's report on business consultants. This pioneer management engineer's name was Jethro. His first and probably his only client was one of the world's great men—Moses.

In the 18th Chapter of Exodus will be found Jethro's complete engineering report, including his observations, his recommendations for improvement, a forecast of the results to be achieved, and the actual results. The problem was that the great Hebrew leader was wearing himself out and might not be able to endure until his great work as leader of exodus was concluded. Jethro, the management engineer, made a study of the problem. His observations showed that his leader spent all his long days

in settling disputes and in directing the activities of his thousands of followers. His observations further showed that there was a great waste of manpower caused by hundreds of men constantly waiting to have their problems decided; a bottleneck existed which delayed progress. In Jethro's own word, "This thing is not good."

Jethro's recommendation was that an organization of supervisors be built up. There should be four grades of supervisors having charge, control, and authority over 10, 50, 100, and 1000 men, respectively. To train the supervisors, it was recommended that they be taught the laws and ordinances, shown the work they must do, and the way it should be done. He further specified that these supervisors must be able men.

Jethro had a good client. The report says that Moses hearkened and did all that Jethro said. The actual result was that only great matters were brought before the leader for his attention.

All engineers may long to have a Moses for a client, a man who will permit a competent study to be made, who will possess his soul in patience while recommendations are being developed, and who will then execute the recommendations in such a whole-hearted and capable manner that the benefits which were forecast will be quickly translated into actualities.

Responsibilities to Workers

The early specialist in industrial engineering concerned himself largely with methods of operating machines in manufacturing plants and with the people who operated them. The pioneers taught that management had responsibilities toward the worker—to select and fit each worker for the correct task, to train him, to plan his work, and to com-

Marketing Problems

Channels of distribution	21
Merchandising methods	15
Salesmen's compensation	14
Market research	13
Sales quotas and potentials	10
Pricing	9
Sales promotion	7
Product acceptance	6
Sales office procedures	5
Warehouse methods	5
Shipping procedures	4

Personnel Problems

Job evaluation	19
Labor relations	17
Wage and salary administration	16
Personnel policies and practices	15
Employee training programs	14
Merit rating	9

Evaluation of managerial positions	8
Employee benefit plans	6
Aptitude testing	5
Employee attitude studies	2
Administrative procedures	2
Suggestion systems	1
Comparative wage surveys	1

Financial Problems

Budgeting	21
Over-all cost control	20
Fiscal policy	20
Accounting Procedures	15
Capital requirements	13
Taxes	4
Credits and Collections	2

Miscellaneous

Appraisals	7
Construction	6

pensate him in accordance with his worth. But while they taught these truths, they did so more in an abstract than in a practical fashion. They were unable or unwilling to study management's methods of administration except as they concerned a check on the output of workers.

Congressional Activity

In 1911 there occurred an event which revealed in detail many of management's weaknesses. This was the year in which there was a walkout of the unionized machinists and molders of the Watertown Arsenal. These workers petitioned Congress to investigate the entire field of management.

In 1912, after a prolonged and thorough investigation of all phases and types of management, a Congressional Committee handed down its conclusion that no additional legislation was necessary to define the functions of management, or to protect workers from management. The conclusion itself was of no great consequence, but the long-drawn-out hearings focused attention on the methods used by successful management as compared with those less successful.

The way was at last opened for subordinating the concept of management as a personal prerogative and for developing the concept that management is a group of workers whose methods of administration could well be studied by engineers.

Thus the specialized calling of management engineering came into being. The time was just prior to World War I. It became a specialty because there was a need for it and a very definite demand. Its growth as a specialized branch of engineering was hastened by the complexity of modern industry—its size and diversification, its increased costs, the demands of its markets, governmental requirements,

expense elements, and other factors which were undreamed of 40 years before.

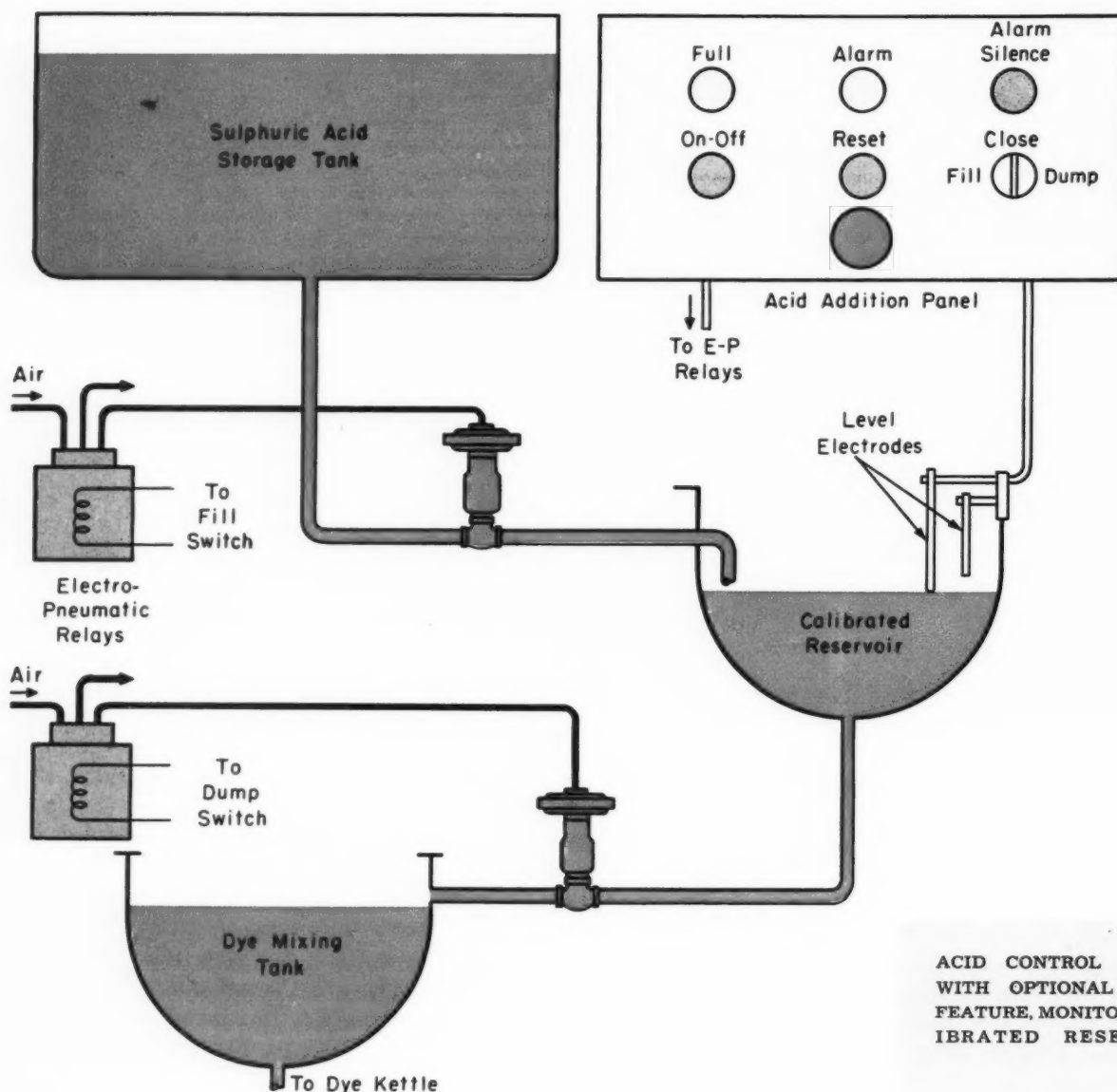
Along with the reputable and qualified consultants came a raft of so-called "efficiency experts" who apparently read a book and then hung out their shingles. For a while they preyed on gullible industrialists but they soon had their day and the designation "efficiency expert" has largely disappeared. Even now it sometimes crops up as a term of derision. Unfortunately a few legitimate successors of these "malpractitioners" are still around. Perhaps it is some comfort to remember that there also are some quack doctors and shyster lawyers.

Not only does the factory executive of today have to manage a greatly complicated physical machine but he has other factors to deal with. One of these stems from the fact that over the last 20 years the country has steadily approached a labor economy with all that it entails. Another major complication arises from the increase in government regulations, restrictions, exactions, and taxes. Between the demands of labor and government it sometimes seems that top management has little time and energy left to attend to other details of running its business successfully and to producing a fair return for the stockholder.

Inside Departments

It is significant that many progressive concerns of all kinds have recognized the importance of maintaining management research people within their own organization. They have made definite provisions for carrying on such work, under various names and at various levels. Thus there are time-study departments, standards departments, methods engineering departments, methods departments, sys-

—Continued on page 72



ACID CONTROL SYSTEM,
WITH OPTIONAL ALARM
FEATURE, MONITORS CAL-
IBRATED RESERVOIR.

Liquid Level Control

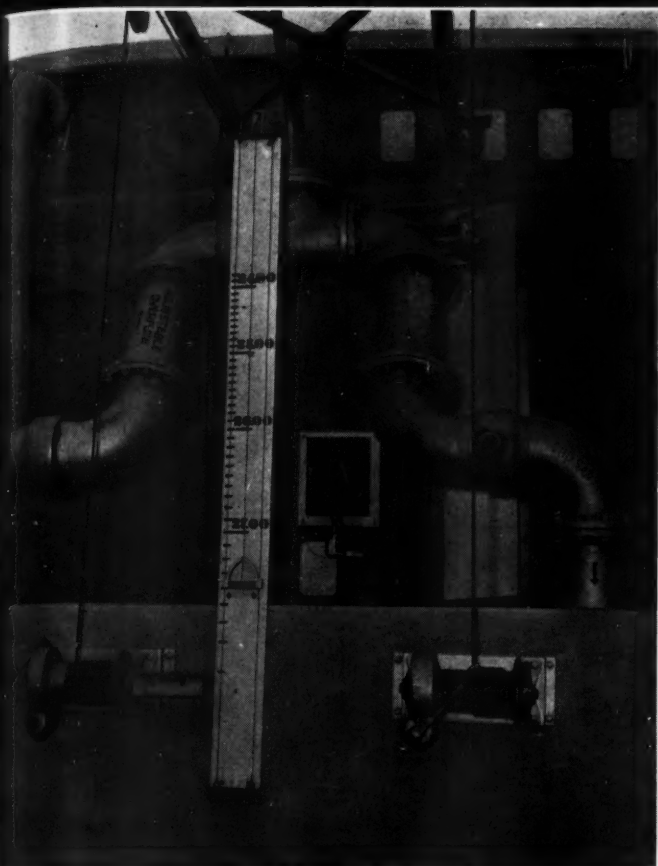
S. D. ROSS
Minneapolis-Honeywell
Regulator Company

LIQUID LEVEL closely competes with the other major variables of temperature, pressure, and flow as a variable of key importance for automatic control. Measurement of liquid level may often be made as a simple check on the quantity of liquid on hand in a storage tank or on the exact amount drawn from storage for use in a process or plant operation. In such cases automatic control may be secondary; at most, simple high or low cut-off action or alarms may suffice. On the other hand, operation of many continuous processes or modern steam generators would be difficult today, if not

impossible, without the aid of liquid level controllers. Here, control of level in a vessel is usually desired about one point, or over a limited range.

Sensing Devices

The importance of liquid level control is evidenced by the numerous types of controllers developed or adapted specifically for this function. These may be classified into several major groups. The first is the family of float-type mechanisms in which the buoyancy of the liquid is used to move a float up or down with changes in level. This movement is



SLUDGE LEVEL IN DIGESTER TANK IS SHOWN BY ONE OF 24 ALARM-INDICATORS IN SEWAGE PLANT.

translated by various means into control action (usually the positioning of a control valve on the vessel's in-flow or out-flow line).

Secondly, there are the displacer-type mechanisms, which also employ the buoyancy effect of the liquid on a long, vertical "displacer"; the displacer is totally or partially submerged in the liquid as its level changes. The displacer is buoyed up by a force in relation to the amount of liquid it displaces. The amount displaced depends on the level in the vessel, thereby creating an upward force which is a measure of the level and which can be translated into control action.

Third are the hydrostatic systems which measure the head effect of the liquid by either conventional pressure gages or manometers (for vessels at atmospheric pressure) or by differential pressure manometers (for pressurized vessels). The differential pressure manometers measure the difference between pressure over liquid and hydrostatic head plus pressure over liquid; thus they are unaffected by changes in vessel pressure. Instruments in this class embody the same basic control mechanisms employed for pressure or flow control.

Electrode or probe systems maintain liquid level at one point or between set limits by using fixed electrodes which close an electrical circuit when a conducting liquid contacts them.

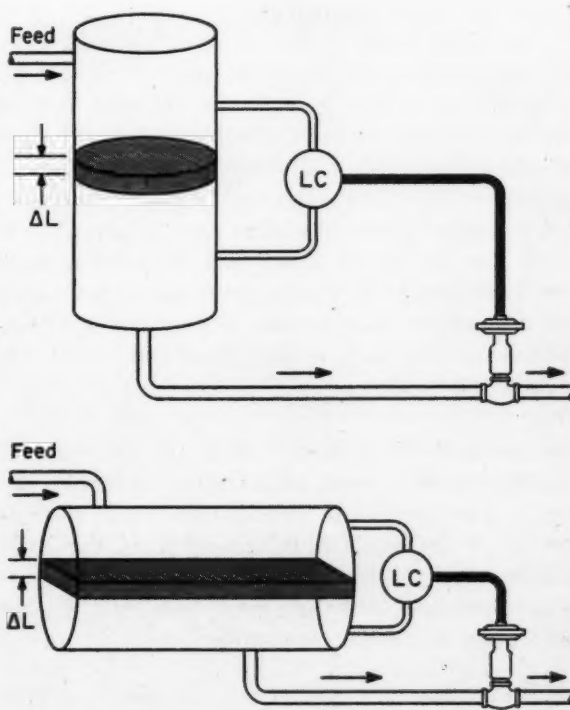
In addition to these group classes and the numerous specific types within them, there are a number of more specialized methods: the common gage glass with photoelectric cell to detect the de-

sired cut-off level or alarm point; boiler level controls utilizing the heat effect to expand a tube for control or to operate a hydraulic system; sonic-type devices employing the reflection of sound waves from the liquid surface; devices using gamma ray emission from a radioactive source; and devices employing the effects of the liquid on the electrical capacitance of a probe-type electrode.

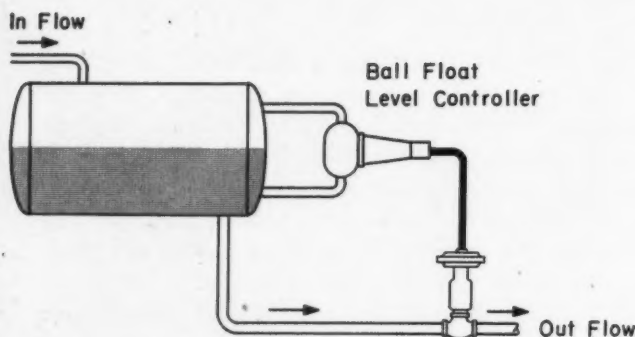
Oftentimes special control devices have their origin in a peculiar problem which cannot be solved by conventional methods. For example, the gamma ray device can measure liquid level through a vessel wall without direct contact with the liquid. Hence it is invaluable in cases where extremely high pressures or corrosive liquids make any opening highly undesirable.

Effect of Vessel Shape

One of the basic principles of all automatic control involves the process characteristics of "capacitance"; this is easiest to visualize in liquid level control. It is obvious that a given cylindrical vessel with in-flow and out-flow regulated by a level controller will be easier to control if laid horizontally on its side than if placed vertically on one end. As illustrated, a given change in level, ΔL , in the vertical vessel represents much less volume of liquid than does the same change in the horizontal vessel. Expressed another way, a change in rate of in-flow would obviously bring about the change, ΔL , much



THE VESSEL'S SHAPE AND POSITION HAVE GREAT EFFECT ON CONTROLLABILITY OF LIQUID LEVEL.



THIS INSTALLATION IS TYPICAL OF THOSE USING BALL-FLOAT CONTROLLER WITH AIR RELAY PILOT.

faster in the vertical vessel than in the other vessel.

Thus, it is seen that the "capacitance" or change in volume per unit change in level is much greater for the horizontal vessel so that a simple two-position or proportional mode of control might easily control the level within the desired limits. Conversely, it should be noted, however, that in terms of volume, the accuracy of measurement with a given instrument in this case of the horizontal vessel would be less than with the vertical one.

Self-Regulation

Another factor to consider is termed "self-regulation." In a vessel which is open or vented to the atmosphere, assume that liquid flows in the top and out the bottom without automatic control. The laws of flow state that, with a given area for flow, the rate of flow is proportional to the head or pressure differential. In a vessel, as level builds up with increased in-flow, the hydrostatic head naturally increases and causes an increase in out-flow.

If the vessel is tall enough and if the in-flow does not increase too greatly, it is entirely possible for the head to increase sufficiently to cause the out-flow rate to balance out the increased in-flow rate. This is perfect "self-regulation," a factor of obvious significance in control because in the ideal case cited it obviates the need for any external device to regulate the liquid level. In actual plant equipment, however, such ideal conditions do not usually exist; some form of controller is required to prevent over-flow or complete emptying of the vessel. Self-regulation in such cases helps the controller do its assigned job.

In pressurized vessels, self-regulation may be present to some extent; with higher pressures, however, it may be all but eliminated. When the pressure above the liquid is relatively high, the hydrostatic head of the liquid is only a small fraction of the pressure and self-regulation due to hydrostatic head is not a significant factor.

Float Controllers

For automatic control, various types of liquid level controllers offer certain advantages and limitations. The float-type mechanisms include the sim-

ple and inexpensive ball float unit which, for open vessels, can be connected directly by a linkage to operate a valve on the in-flow or out-flow line. For vessels under pressures up to 1000 psi or under vacuum, the unit may employ a stuffing box seal, or may be constructed with an external float cage connected to the vessel very much like the common gage glass.

Limited Range

All these find wide application where their somewhat limited level range (equal to the length of the ball-float connecting rod) is suitable. As is true of all float-type mechanisms, the liquid must not coat the float or attack it chemically; otherwise, the buoyancy of the float will be altered. Direct-connected types must be located close to the valve; they develop only limited power to overcome the hydraulic forces in the valve. They are usually limited to applications where the pressure drop across the valve is 100 psi or less.

Float-operated devices of the cage type have been designed with an air pilot unit to overcome the power and distance limitations in operating the control valves. Limitations in the level range led to the chain or tape float gage which can measure level ranges up to some 60 feet. These gages can be used with suitable pilot relays or electric systems for remote indication or control.

Displacer Mechanisms

Increased accuracy and wider range is provided by displacer-type units which are commonly used in industry today. Their range is usually from about 14 inches to about 15 feet, although one type is available for levels up to 60 feet. Pressure ratings vary from 125 to 2500 psi. The displacer is normally mounted in an external cylindrical chamber connected to the vessel as illustrated for the float cage; such a unit usually incorporates a pneumatic transmission or control mechanism.

Hydrostatic Systems

Conventional pressure controllers require only calibration of their scale to be usable for liquid level control in open vessels. (The relation between static pressure and level is given by the expression $P = D \times H$, where P = pressure in psi, D = density of liquid in lb/cu in., and H = height of vessel above pressure tap in inches.) Because the density of the liquid is a factor, it is obvious that in this system the density must remain relatively constant. Also, because the system is a function of total head, it is not suitable for controlling the interface level between two immiscible liquids. Range of levels to be controlled are practically unlimited, since elements are available for pressures far in excess of those developed by hydrostatic heads in open vessels.

As is true for use of differential manometers for

open or pressurized vessels, pressure gages are often installed with air purges in dip tubes, with diaphragm seals, liquid seals, or a variety of devices to prevent plugging of pressure connections with entrained solids, or to protect the measuring element from corrosive liquids. Pressurized vessels up to 10,000 psi or more can be measured and controlled by any differential pressure instrument such as the mercury manometer, the dry bellows meter, or the pneumatic-balance "mercuryless" meter.

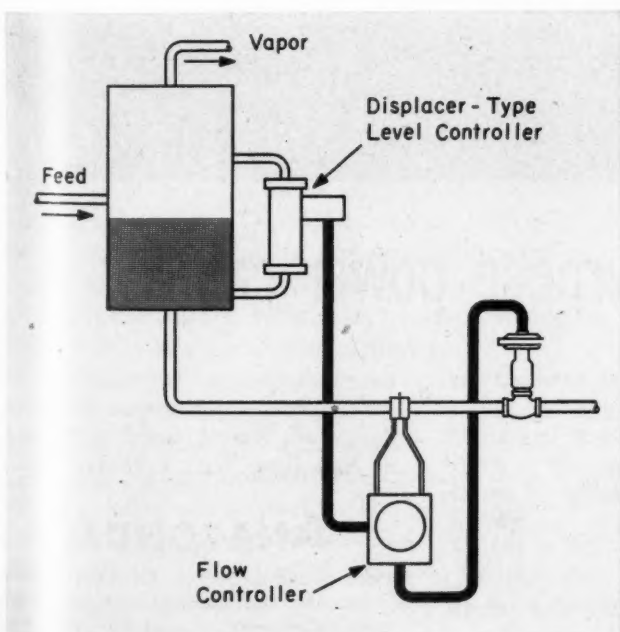
"Averaging" Level Control

In any process where the in-flow or out-flow is throttled by a valve as a means of level control in a storage or "surge" vessel and where sudden changes in this flow are not permitted because of their undesirable effects or process stability, "averaging" liquid level control is employed. In this type of control, the level is permitted to drift gradually up or down in the vessel following sudden changes in load (uncontrolled in-flow or out-flow, as the case may be). Instead of being controlled at one point, the liquid level is averaged between limits which depend on the vessel height and capacity.

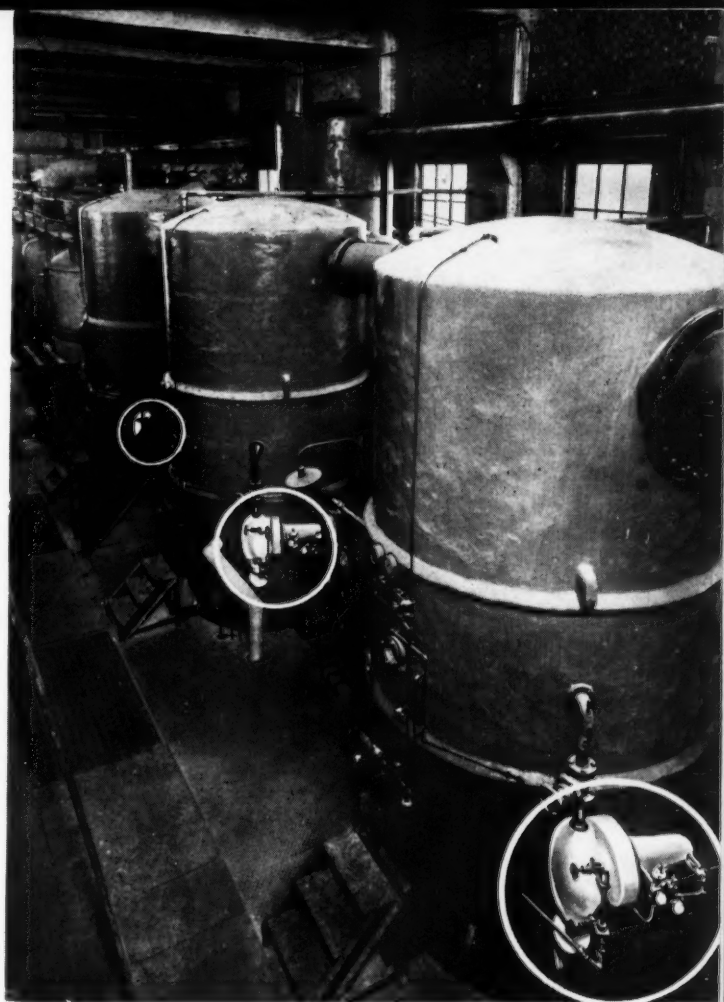
Interlocked Control

In an interlocked arrangement, the flow controller may be arranged to react quickly to changes in pressure which would change liquid level over a period of time. A level change is thus arrested before it occurs. For averaging level control, the proportional band adjustment of the level controller is set wide as discussed above, or narrower for exact control at one position.

Modern high-pressure steam generators in many



INTERLOCKED LEVEL AND FLOW CONTROLLERS ARE USED FOR PRECISE OR AVERAGING LEVEL CONTROL.



FLOAT CAGE CONTROLLERS REGULATE LIQUID LEVELS IN TRIPLE-EFFECT CAUSTIC SODA EVAPORATORS.

cases require refinements in water level controls which are interlocked with steam flow and sometimes feedwater flow as well. These refinements for boilers are often necessary due to rapid changes in steaming rate which develop a greater portion of steam below the water level and which create a false change in level without any change in feedwater rate. Such swells in a simple level control set-up may call for a decrease in feedwater flow just when the opposite is required.

To compensate for such a condition, interlocked control systems have been designed for (1) two-element control, wherein steam flow and water level are interlocked so that a control valve on the feedwater line varies its flow rate in accordance with changes in steam flow as well as with water level; and (2) three-element control, wherein the feedwater flow rate is interlocked as well.

The latter system resembles the interlocked averaging level control system in that corrections are made to the feedwater valve position whenever the set ratio between feedwater in-flow and out-flowing steam are disturbed. Actual level control is secondary. The three-element system maintains a higher-than-normal level at high steaming rates to provide more capacity for demand, and a lower-than-normal level at low steam rates to prevent carry-over.



Durasheath: all-purpose power cable

In heavily industrialized areas, utilities can cut their installation and maintenance costs with light, tough DURASHEATH*. This flexible, easily handled cable may be run buried in the earth, in ducts or overhead (or in any combination) without needless, time-consuming jointing. Its light weight and flexibility make duct pulling fast even in zero weather. Aerial assemblies go faster. Linemen like to work with it. And

you need stock only one cable type.

* * *

As one of several types of ANACONDA power cables, DURASHEATH is available in all sizes, single or multi-conductor, copper or aluminum, from 600 to 15,000 volts. It is thoroughly dependable for industrial plants, railroads, series or multiple street lighting, traffic control, and airport† lighting, residential primaries and secondaries, as well as

for such uses as Type USE cable for underground service entrance. *Anaconda Wire & Cable Company, 25 Broadway, New York 4, N. Y.*

*Reg. U. S. Pat. Off. 53315

ANACONDA®

Primary and secondary distribution cables • building, machine tool, control and communication wire • portable cords and cables • bus-drop cables • apparatus cables • copper, aluminum, copperweld conductors • wire and cable accessories.

†when ordered to CAA Specifications L-824



the Range Finder

DR. GERALD J. MATCHETT

Department of Business and Economics

and

Director, National Center of Dynamic Equipment Policy

Illinois Institute of Technology

WHAT IS EXCESSIVE profit? In his State of the Union Message to Congress on January 7, 1954 President Eisenhower said: "Immediate extension of the Renegotiation Act of 1951 is also needed to eliminate excessive profits and to prevent waste of public funds in the purchase of defense materials."

The definition of reasonable profit is a question of dollars and cents to the many businesses dealing with the government under contracts subject to renegotiation. For these firms, the collection and development of data required when contracts come up for renegotiation may be something of a headache. Referring to his own experiences in the matter, an executive of a large corporation recently remarked, "Even with a staff of specialists equipped to handle this type of problem, we found that getting the material together for the Renegotiation Board was a real job. It must be a far bigger one in a small firm with no special set-up for cost analysis."

Consultants and Renegotiation

He was right. There is a growing need for consultants able to assist firms in problems associated with renegotiation. The fundamental principles of the renegotiation process are straightforward and clear. However, their application to the special set of conditions under which any one company operates is not always a simple matter.

In essence, renegotiation is a system developed by the government for the purpose of recapturing "excessive profits" on government contracts. It is applied to contracts and subcontracts let by a number of government agencies. The entire procedure—the specification as to which contracts are renegotiable as well as the bases for analyzing profits—is based on the Renegotiation Act, as enacted in 1951 and subsequently amended. The Act provides the framework within which the Renegotiation Board operates in determining a fair profit. Profits

will be greater or less, for example, depending upon the size of depreciation allowances and the way in which overhead is allocated.

In any attempt to define a reasonable profit one finds himself in the realm of intangibles. Finding a reasonable level of profits does not lend itself to any time-proven formula. Instead, it is necessary to begin the analysis with a number of accepted generalities. A reasonable profit for renegotiation purposes will be one which will compensate for the service performed, risk assumed, responsibility taken on and fulfilled, capital employed, and know-how and experience put into the job. In addition, it must provide a margin for unforeseen contingencies and cost requirements.

The statutory factors which have been developed for renegotiation are framed in the light of these requirements. But these general considerations still do not provide a solution to the problem of determining a fair profit; a bench mark is required. One such bench mark will be the prices, costs, and profits of other contractors engaged in the production of similar products using similar processes. Another may be the contractor's own past profit experience evaluated on the basis of sales, capital, or market value of his company.

Renegotiation Data

When a contractor appears before the Renegotiation Board, he is given an opportunity to present whatever information he considers pertinent to an analysis of his profits under a government contract. In compiling this material, the first step to be taken is an obvious one—the preparation of a statement concerning the portion of sales which are subject to renegotiation and an explanation of the methods used in arriving at this amount. The costs chargeable against this part of the firm's business must be isolated in the same way. Once this segregation of costs has been made, facts and conclusions concern-

ing the renegotiable portion of the firm's business can be developed.

To present a good case, the firm needs knowledge regarding the detailed requirements as set forth in the Act and in the Board regulations. The Board will give the contractor every reasonable assistance in this matter. It is imperative that he know what the Board will consider under various types of contracts and that he compile his factual and financial information accordingly.

Statutory Factors

The determination of a fair profit depends on many considerations. A list of the factors involved suggests the variety of data which must be presented if the contractor's profit position is to have an accurate appraisal.

The first of these factors deals with the efficiency of the contractor. This provision states that favorable recognition will be given to "the efficiency of the contractor or subcontractor, with particular regard to attainment of quantity and quality production, reduction of costs, and economy in use of materials, facilities, and manpower." In effect, the firm must show that it is an efficient producer. Facts and figures must be organized to show that production and delivery schedules were met, quality standards were adhered to, unit costs were reduced, and efficient equipment and methods were used.

The second statutory provision states that the Board will consider "reasonableness of costs and profits, with particular regard to volume of production, normal earnings, and comparison of war and peacetime products." Comparisons are made with current costs and profits of other contractors and with the contractor's own costs and profits in other years. Particular attention is given to expense ratios which can be shown to have decreased as a result of managerial effort and control.

The Act provides that consideration be given to "the net worth, with particular regard to the amount and source of public and private capital employed." The ratio of profit realized on renegotiable business to the capital employed in this business will play a role in establishing a reasonable profit. In addition, more favorable consideration will be given to a firm which is not dependent upon

government or customer financing than to one which is. In other words, the Act makes a distinction between firms contributing capital, as well as production management, and firms whose contribution tends to be one of management only.

The fourth statutory factor deals with "extent of risk assumed, including the risk incident to reasonable pricing policies." It is in this area that the contractor has the best opportunity to explain what appears to be high profits. He can elaborate on the danger of possible saturation of markets, loss of commercial customers to competitors, expensive and difficult reconversion, cutbacks or cancellations, delays due to inability to obtain equipment or materials, and the like. In the case of fixed price contracts, there is the risk of possible increases in material and wage costs. The contractor may also be able to show that work was accepted at a price which entailed a high risk of loss.

Shared Knowledge

In determining excessive profits, the fifth factor provides that the following shall be taken into consideration: "Nature and extent of contribution to the defense effort, including inventive and developmental contribution and cooperation with the Government and other contractors in supplying technical assistance." To show evidence of this contribution, the manufacturer may point out inventions developed by his firm and the application of new techniques and processes of unusual merit. He may also show that he shared his technical knowledge with potential competitors in commercial extensions of the defense production.

The sixth, and last, statutory provision requires that renegotiation officials consider "character of business, including source and nature of materials, complexity of manufacturing techniques, character and extent of sub-contracting, and the rate of turnover." Under this provision the Board will consider such factors as degree of skill and precision required, degree of integration in the manufacturing process, complexity of the manufacturing technique, degree of subcontracting, and the rate of turnover of plant, materials, and net worth.

Without question, these are problems which consulting engineers may well find challenging.

Virginia Power Licks Rising Plant Costs

MORE POWER is being produced in less space and for less cost for both the plant and the power per kw in the new 100,000-kw installation of the Virginia Electric and Power Company in Chesterfield, Va. A new controlled circulation boiler is saving \$250,000 in costs and weighs 1,000,000 pounds

less than conventional equipment of equal capacity. The controlled circulation boiler is 8 feet narrower than a natural circulation boiler erected in 1949 which produces only 66,000 kw, which is 34,000 kw less than the new unit just installed. Stone and Webster Engineering Corp. is consultant on the job.



the Legal Aspect

MELVIN NORD

Consultant in Legal and Technical Problems
Registered Professional Engineer
Chemical Engineer
Patent Attorney



ENGINEERS GENERALLY regard a patent as some kind of joke, written in a secret language (like a doctor's prescription) or as something "—full of sound and fury, signifying nothing." Lawyers generally refuse to go anywhere near a patent, apparently feeling it may bite them. (There are only two recognized "specialists" in law — patent and admiralty law.) The public somehow seems to have the impression that the word "patent" is practically synonymous with "monopoly," "cartel," and "evil." Judging by the high percentage of patents ruled void, the courts think patents are "glorified gadgets" or worse. And business men are not certain whether patents are equivalent to oil wells or "dry holes."

Two-Way Proposition

It is a great mistake to think that the public is giving the inventor some great reward when it awards him a patent. It is strictly a two-way proposition, with each party getting something of value. The only reward to the inventor is that he is protected from "pirating" for 17 years after he makes his disclosure. The benefit to the public is that it becomes the owner of the invention after 17 years and gets the benefit of the disclosure immediately.

It is an equally great error to think that the award of a patent to an inventor is what makes people invent things — that it is this reward which is promoting progress in the arts or sciences. Actually, it is the reverse; what is promoting this progress is not the award of the patent by the government, but the disclosure of the invention by the inventor to the public! Anyone who has ever seen an inventor from close up knows that you can't stop him from inventing even if you tie his hands behind his back under water.

The award of a patent rarely, if ever, stimulates someone to invent something. But it nearly always stimulates him to disclose it. The theory that an inventor invents in order to get a patent is easily

disproved when one observes that most patents are issued directly to an assignee of the inventor, who generally is his employer. The inventor generally has little or no personal stake in the patent. He invents because he is an engineer, a scientist, a researcher, or an inventor, not primarily because of the possibility of patent rights.

Many people fail to understand the basic nature of the patent system. They — especially judges — feel that a patent is a monopoly taken from the public and bestowed on a private individual and is therefore to be restrained like a wild beast. We have already seen that a patent is not something taken from the public. Now let us see whether it is one of those "dirty" things — a monopoly.

The patent law gives the inventor the "exclusive right to manufacture, use or sell" his invention. This is undoubtedly a monopoly. But it is also precisely the definition of ownership — ownership of the exact same kind as ownership of any form of property. The ownership of land simply means the right to exclude others from the use and enjoyment of it. The same is true of a book or of any property. A patent is a monopoly in exactly the same sense as the ownership of any property is a monopoly.

Attacks on Ownership

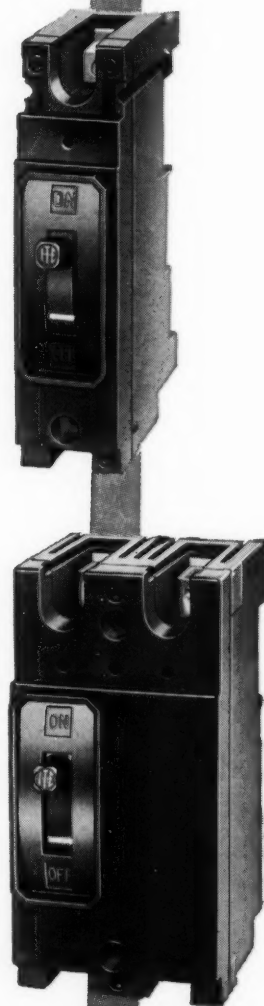
Attacks on the patent system as the creator of monopolies are about as logical as attacks on any kind of ownership. Ownership of land is not inherently good or bad. The real question is, what do you do with your ownership? Of course, there have always been some people who regard ownership of property as inherently wrong. Some people feel that ownership of land is basically antisocial. Others feel that the ownership of capital is basically evil. It will be time to start beating the patent system to death only when we are ready to acknowledge that ownership of any form or type of property is inherently wrong.

NEW I-T-E 100-AMPERE "E"

Completely new design in 1-, 2-, and 3-pole construction!

All these I-T-E quality features:

- 1 **Thermal-magnetic tripping**
gives complete protection against overloads and short circuits.
- 2 **Quick-make, quick-break contact action**
assures long breaker life.
- 3 **"Common trip" operating mechanism**
opens all poles simultaneously when there's an overload on any one pole.
- 4 **"Trip-free" handle mechanism**
prevents breaker from being closed against faults.
- 5 **Three-position handle**
indicates whether breaker is ON, TRIPPED, or OFF.



Available in ratings from—

15 to 100 amperes
1 pole: 125 volts a-c, d-c
2 pole: 250 volts a-c, 125/250 volts d-c
3 pole: 250 volts a-c, 125/250 volts d-c
5,000 amperes interrupting capacity



CONSULTING ENGINEER

Utilities Schedule New Construction

AN ALL-TIME RECORD VOLUME of approximately \$46.5 billion in total construction was put in place in the United States in 1953. New construction exceeded the 1952 volume by 6 percent, marking the eighth successive year that new dollar volume records have been established. In predicting the outlook for 1954, experts point to a number of favorable factors indicating a continued high rate of activity.

Among those industries exceeding previous construction marks are the privately-owned public utilities, which registered the seventh successive record year in construction expenditures — \$4.4 billion in 1953. New records were established in both the electric light and power group, and in the petroleum pipeline category.

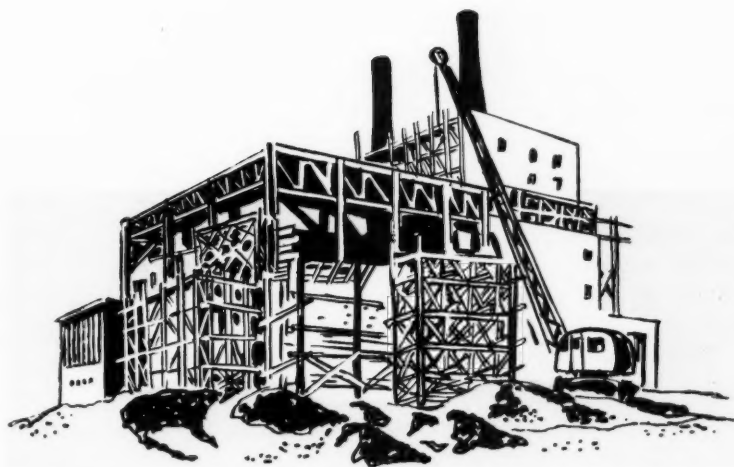
Since the beginning of our electrical age, approximately 75 years ago, the electric utilities have consistently doubled their capacity and output in each decade. The industry is now planning for another doubling in the next decade, and many predict this point will be reached within eight years. It is estimated that the total expenditure by the privately-owned electric utilities alone will amount to \$20 billion in the post-war decade.

Total generation of electricity in the United States passed the half-trillion kwhr mark in 1953. Power generation by the entire electric industry, including privately-owned companies, co-operative, and governmental agencies, reached 442 billion kwhr in 1953. Production by industrial and railway plants was 71 billion kwhr, bringing the grand total to 513 billion.

Electric Utilities

Among the current and prospective construction programs planned by the electric power utilities is a three-year, \$105.5 million program planned by Alabama Power Co. This program was revealed when the company recently asked the State Public Service Commission for authority to issue \$17 million in bonds and 80,000 additional shares of common stock worth another \$8 million to finance the first \$33.8 million of the work in 1954.

Other construction projects scheduled by utilities in the South include an \$18 million expansion program being carried out by the Jacksonville, Fla., municipal electric department. This program is



being financed through revenue certificates.

The Savannah (Ga.) Electric & Power Co. is about two-thirds of the way through the latest phase of an improvement program which has seen at least \$9 million spent on gross expansions since the end of World War II. The latest addition is a 4.5 million expansion of the firm's Riverside station.

Louisville Gas & Electric Co. has announced that work would start immediately on the installation of a second steam-operated 100,000 kw generating unit at its Cane Run plant at a cost of \$13.8 million. Cost of the first unit plus the plant was approximately \$15 million.

Plans reported by Virginia Electric & Power Co. call for a \$1.7 million transmission line between the company's Portsmouth, Va. generating station and the village of Hickory, in Norfolk County.

Considerable construction work also is being planned by utilities in the western states. Plans to spend nearly \$57 million for new plants and equipment during the next four years have been announced by the Public Service Company of Colorado. Included in these plans will be a \$19 million power plant in the Denver area.

Idaho Power Co. has announced a 10-year construction budget of \$261 million to provide new generating plants, and transmission and distribution facilities. The company, since 1946, has invested nearly \$100 million in system improvements.

Arizona Public Service Co. plans to start construction, this spring, on a new 100,000 kw steam generating plant expected to cost \$14 million. The new plant will be in addition to the \$26 million Saguaro generating plant now being constructed.

Public Service Co. of New Mexico is carrying

out a three-year, \$22 million expansion program to meet the electric light and power needs of its area, which have increased by 130 percent during the last 10 years.

In the Midwest, plans for \$22.5 million of expansion this year, and \$26.5 million in 1956, were disclosed by Northern Indiana Public Service Co. in connection with the offering of a new issue of 318,000 shares of no par common stock.

Ohio Edison Co. was authorized by the State Utilities Commission to sell \$30 million in first mortgage bonds and issue 527,830 shares of common stock. Proceeds will reimburse the firm's treasury for expenditures made on improvements. The company's application showed that \$58 million was to be spent in property additions in 1953, and \$54.5 million is planned for 1954.

Consumers Power Co. has announced plans to spend more than \$63 million to expand and improve its electric and gas facilities in its 63-county out-state Michigan service area.

In the Pittsburgh area, the Duquesne Light Co. is in the midst of a \$225 million expansion program. Another Pennsylvania utility firm, West Penn Power, is investing \$115 million to expand its electric generating capacity.

Philadelphia Electric Co. plans to spend approximately 16 percent more for expansion of its facilities in the five years of 1954 through 1958 than it did in the preceding five-year period. The expansion is needed to meet growing needs of the firm's customers in the Delaware Valley. The company estimated its construction expenditures for the five years through 1958 at \$310 million, of which \$76 million, will be spent in 1954. Of the total scheduled for 1954 through 1958, approximately \$257 million will be for electric facilities, \$30 million for gas facilities, \$7 million for steam facilities, and \$16 million for facilities used in all operations.

Natural Gas

Late last year, four natural gas companies asked the Federal Power Commission for authority to construct transmission facilities estimated to cost over \$168 million, including a pipeline from Louisiana to Michigan. American Louisiana Pipe Line Co., Detroit, a new firm, contemplates a 1289-mile system with a daily capacity of 300 million cubic feet of gas daily. Cost of the pipeline would be \$130 million. Michigan-Wisconsin Pipe Line Co. and Michigan Consolidated Gas Co., both of Detroit, would construct new facilities to receive gas from American Louisiana. All three companies are subsidiaries of American Natural Gas Co.

Texas Gas Transmission Co., Owensboro, Ky., plans to construct facilities costing over \$4 million to enable it to sell about 51 million cubic feet of gas daily to American Louisiana.

Arkansas Louisiana Gas Co., Shreveport, La.,

filed for FPC permission to construct a \$9 million project which would permit a 28 percent expansion of its gas deliveries by 1956. Construction of 107 miles of pipeline and other facilities are planned on the company's gas transmission system which covers most of northern Louisiana, part of Arkansas, and a small area in east Texas.

W. W. Clawson, general manager of the Pegasus division of Socony-Vacuum Oil Co., recently announced plans for construction of a gas plant near Manderson, Wyo. Construction work on the new facility, to be known as the Big Horn plant, is scheduled to begin this spring. The plant will treat 15 million feet of sour gas daily from Slick Creek, Manderson unit, Driveway area, and other nearby fields. Hydrogen sulfide will be removed from the gas and delivered to an adjacent sulfur reduction plant owned by Jefferson Lake Sulphur Co. of New Orleans. The bulk of the "dried" gas will be purchased by Montana-Dakota Utilities Co. for distribution in its system.

An application has been filed by North Dakota Natural Gas Co., St. Paul, Minn., for permission to build and operate a 500-mile, \$12.5 million natural gas pipeline in North Dakota.

Telephone

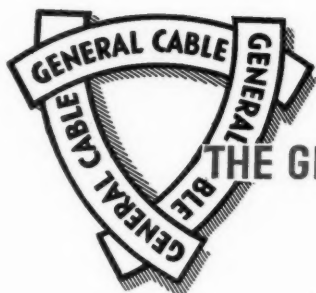
Another public utility having a consistent record of marked expansion is the telephone industry. Telephones are being installed at the rate of 200,000 a month. In 1953, the number of installed telephones in the United States passed the 50 million mark.

Mountain States Telephone & Telegraph Co. has revealed plans for expenditure of \$70 million during 1954 for additions and improvements to its telephone facilities in the Rocky Mountain area. A similar amount was spent by the company in 1953, adding nearly 84,000 telephones to the firm's system.

A feature of Mountain States' expansion program in Colorado will be conversion of exchanges in Boulder and Pueblo from manual operation to dial phones. The program also includes plans for expenditure of at least \$12 million on improvements in Arizona during 1954. About 50 percent will be spent in the Phoenix area, and 25 percent in the Tucson area.

New expenditures of \$4.1 million have been authorized by directors of the Chesapeake and Potomac Telephone Co. This will bring the total expenditures contemplated by this company for new construction in Maryland to \$33.7 million this year.

Southwestern Bell Telephone Co. has announced plans to spend \$28 million in Arkansas in the next three years, including conversion to dials in a number of communities and long-distance system cable improvements. Ohio Bell Telephone Co. reports that its plans for the next few years are to continue further plant expansions at the current rate of \$50 million per year.



THE GREATEST NAME IN ELECTRICAL WIRE AND CABLE



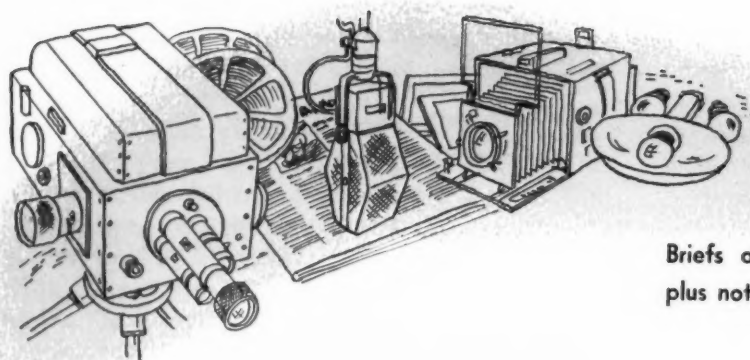
To wire a plant, or wind a coil

IT PAYS TO BUY IN ONE PLACE!

Actually there is only one source for all of the types of wire and cable you may need...that's General Cable. To meet your every requirement, General Cable manufactures bare, weatherproof and insulated conductors of every variety...maintains vast stocks...the broadest distribution facilities in the industry...ultra-modern plants coast to coast. Specify "General Cable." Don't settle for less.



GENERAL CABLE CORPORATION 420 Lexington Avenue, New York 17, New York
 Sales Offices: Atlanta • Buffalo • Cambridge (Mass.) • Chicago • Cincinnati • Cleveland • Dallas • Detroit
 Houston • Indianapolis • Kansas City • Los Angeles • Milwaukee • Minneapolis • Newark (N. J.) • New York • Philadelphia
 Pittsburgh • Portland (Ore.) • St. Louis • San Francisco • Seattle • Syracuse • Tulsa • Washington, D. C.



NEWS

Briefs of current interest to the consulting profession plus notes on new equipment in the field of engineering



Street Lights Are Bigger and Brighter

Designed for wide boulevards, shopping areas, or resort "boardwalks," a bigger and brighter street-light built by the Westinghouse Electric Corporation's Lighting Division accommodates either a 700 or 1000 w mercury or fluorescent mercury lamp. The body and reflector of the new luminaire are aluminum. Called the OV-60, it is mounted at a tilt of 15 degrees, and will provide a uniform distribution of bright light on boulevards up to 125 ft wide. When using the 1000 w mercury lamp, the new street light provides more light on the roadway than does any other street light ever built, according to Westinghouse engineers. Now being readied for mass production, the OV-60 first has been installed as part of Atlantic City's new boardwalk lighting system.

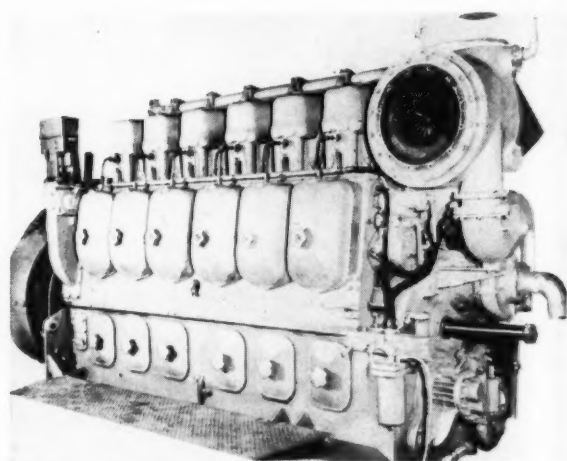
Automatic Voltage Control Ensures Collection Efficiency

For use in the Cottrell process of electrically removing suspended matter from gases, a new system

of precipitator automatic voltage control has been developed to effect maximum collection efficiency.

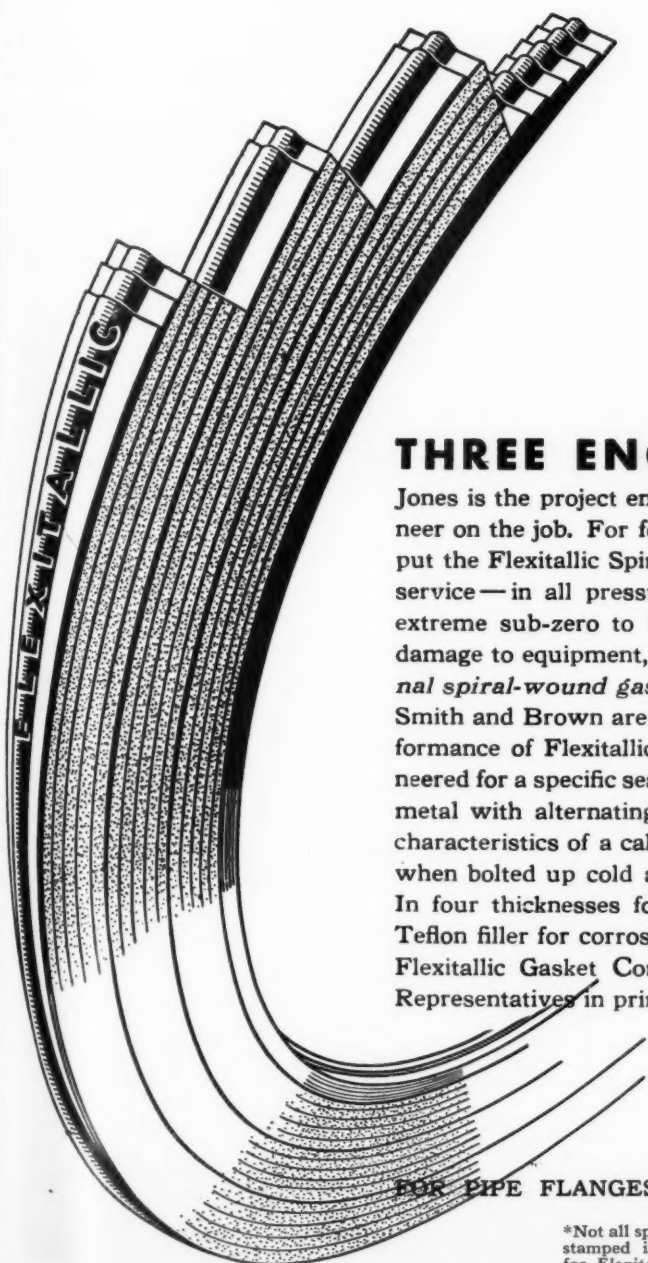
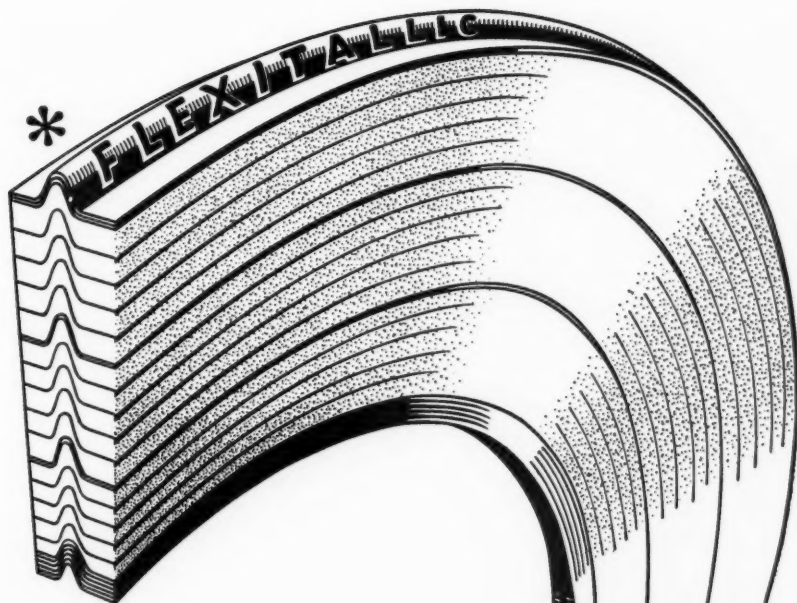
The equipment may be applied to new rectifier sets or as an adjunct to sets now in use. The system was developed by Research Corp. after field tests had shown that, contrary to accepted ideas, maximum collection efficiency usually occurs at operating voltages high enough to cause appreciable precipitator sparking.

It is primarily intended for applications subject to variable load conditions where maximum efficiency can be automatically maintained by continuously operating the precipitator at the highest possible voltage compatible with the dust losses due to sparking. When little or no sparking occurs, the system will automatically maintain operation at full rated power output from the precipitator electrical equipment, thereby ensuring maximum utility of installed transformer capacity. Continuous measurement of the average sparking rate indicated directly on a meter provides a convenient and effective means for quickly checking overall performance.



Diesel-Electric Unit Is Mounted on Skids

Utilizing the type engine proved on thousands of American Locomotive Co. diesel locomotives, this company's new generator can be equipped with a 9 x 10½ in., 4-cycle, turbocharged Alco diesel in



THREE ENGINEERS vs. A GASKET...

Jones is the project engineer. Smith is the piping engineer. Brown is chief engineer on the job. For forty years, they have used Flexitallic Gaskets. They have put the Flexitallic Spiral-Wound Gasket construction through the most rigorous service—in all pressure/temperature ranges from vacuum to 10,000 lbs., from extreme sub-zero to 2000° F. They recognize the penalty of gasket failure—damage to equipment, down-time, danger to personnel—and insist on *the original spiral-wound gasket* made exclusively by Flexitallic since 1912... Jones, Smith and Brown are fictitious names but the confidence of engineers in the performance of Flexitallic Gaskets is a fact!... Each Flexitallic Gasket is engineered for a specific sealing problem. Spirally wound V-cripped plies of required metal with alternating plies of proper filler result in a resilient gasket having characteristics of a calibrated spring. Flexitallic Gaskets are at highest efficiency when bolted up cold at a predetermined load. For all standard joint assemblies. In four thicknesses for special requirements: .125", .175", .250", .285". With Teflon filler for corrosive chemical conditions. Write us your requirements... Flexitallic Gasket Company, 8th & Bailey Streets, Camden 2, New Jersey. Representatives in principal cities. Consult classified telephone directory.

Flexitallic®
SPIRAL-WOUND GASKETS

FOR PIPE FLANGES, PRESSURE VESSELS AND PROCESS EQUIPMENT

*Not all spiral-wound gaskets are Flexitallic. Look for the name FLEXITALLIC stamped into the metal spiral of every genuine Flexitallic Gasket. Look for Flexitallic Blue — it's our exclusive blue-dyed Canadian asbestos filler.

Unit Is Mounted on Skids

—Starts on page 60

sizes ranging from 390 to 1300 kw. In addition to the engine, all auxiliary equipment including generator, exciter, and switch gear is mounted on skids so that by merely connecting the power cables, the unit is ready for operation. The entire power plant can be enclosed in a weather-proof housing eliminating the need for separate building facilities or other protective structures.

The design of the Alco portable generator can also be adapted to pipeline service, flood control and irrigation uses by substituting step-up gears and pumps for electric generating equipment. Because of this versatility, the new Alco unit is extremely well suited to many types of portable power service.

Rio de Janeiro Film Will Be Seen by AICE

An unusually interesting film "The Development of Electric Power for the City of Rio de Janeiro Known as the Forcacava Project," will be shown at the March 3rd meeting of the American Institute of Consulting Engineers. The meeting will be at the Engineers' Club, New York City, 12:30 PM.



First Alumina Plant For Texas Is in Operation

The state of Texas now has an integrated bauxite-to-aluminum operation with the completion of the LaQuinta alumina plant of Reynolds Reduction Co., a subsidiary of Reynolds Metal Co. The plant, which has a rated output of 1000 tons of alumina daily, is located next door to the San Patricio reduction plant.

Taking advantage of mild Texas weather, all equipment is located out-of-doors. Designed especially to process Jamaica bauxite, facilities are built in two sections, each with a rated capacity of 500 tons a day.

Alumina plants operating on the Bayer process,

Pick INSTANTANEOUS HOT WATER HEATERS ENGINEERED FOR SERVICE

Industries everywhere are replacing outmoded water heaters with Pick Instantaneous Water Heaters. Here are the reasons:

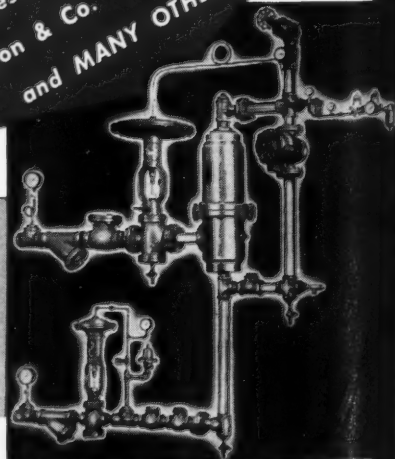
- ★ Water Is Heated Instantly. Entirely automatic, Pick Heaters operate by steam injection to heat the water in a flash to exact temperature desired and in volume required.
- ★ Fuel Savings Are Substantial. Steam injection heating is the most efficient method known. There's no waste because water is heated only as used . . . never stored and allowed to cool.
- ★ No Storage Tanks Required. Compact design of Pick Heaters permits out-of-the-way installation in corners, on walls or overhead. Saves valuable floor space.
- ★ Exact Temperature Control. Pick heaters can be operated at low or high loads with minimum temperature fluctuation. And it's done quietly.
- ★ Maintenance Cost Is Low. Pick Heaters can be cleaned in a matter of minutes — worn parts easily replaced.
- ★ Installation Is Inexpensive. Only ordinary pipe connections are required.

PICK
HOT WATER
HEATERS . . . Used by

- United States Steel Co.
- Ford Motor Co.
- H. J. Heinz
- Bethlehem Steel Corp.
- Hercules Powder
- Wilson & Co.
- and MANY OTHERS



SAVES MONEY FOR ANY
INDUSTRY THAT USES
HOT WATER!

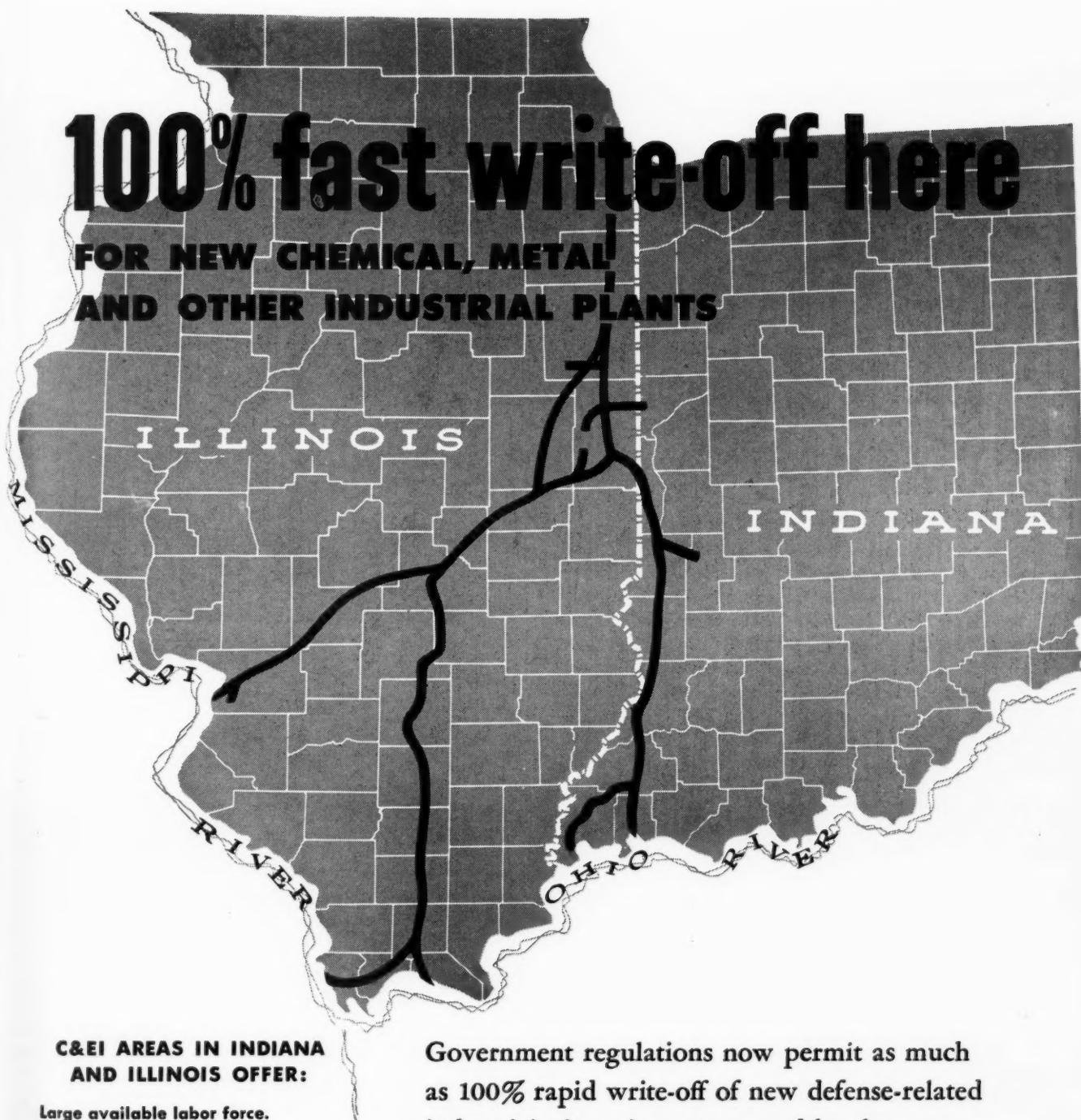


Write for booklet on how PICK HEATERS cut costs of Hot Water — No Obligation. Write CE 154

PICK MANUFACTURING CO. • WEST BEND, WIS.

100% fast write-off here

**FOR NEW CHEMICAL, METAL
AND OTHER INDUSTRIAL PLANTS**



C&EI AREAS IN INDIANA AND ILLINOIS OFFER:

Large available labor force.

Millions of kw capacity at
attractive rates.

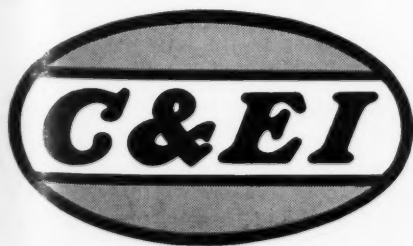
Tremendous, economical fuel supply.

Railroads, river barge lines,
good highways.

Unlimited industrial water supply.

Proximity to major market areas.

Government regulations now permit as much
as 100% rapid write-off of new defense-related
industrial plants in areas served by the
Chicago & Eastern Illinois Railroad.
For a list of these C&EI communities and
their outstanding industrial advantages,
write—in confidence—to Chief Economist,
Chicago & Eastern Illinois Railroad,
332 South Michigan Avenue, Chicago 4, Illinois.



CHICAGO & EASTERN ILLINOIS RAILROAD

Alumina Plant Is in Operation

—Starts on page 62

such as this one, have need for considerable quantities of process steam. At LaQuinta, steam is generated in boilers at a pressure of 850 psi. The electric power required for plant operation is produced by non-condensing turbo-generators, the exhaust steam then being used for processing.

Fuel for boilers and calcining kilns is natural gas with plant requirements totaling approximately 20 million cu ft daily. Fresh water requirements, approximately 2½ million gal each day, are drawn from Corpus Christi through a 28-mile pipe line.

Executives Comment on Cleveland Engineering Center

"It's just plain, good business for industry to improve the engineer's environment," Elmer Lindseth, president, Cleveland Electric Illuminating Co., told Northeastern Ohio industrial executives attending dinner at the Cleveland Engineering Society.

One of four industrial leaders commenting on the recently announced \$1,378,000 building and development program of the Society, he also stated that the proposed Engineering Center would help to make Cleveland a better place for an engineer to

take a job, and would give industry a better chance of keeping him.

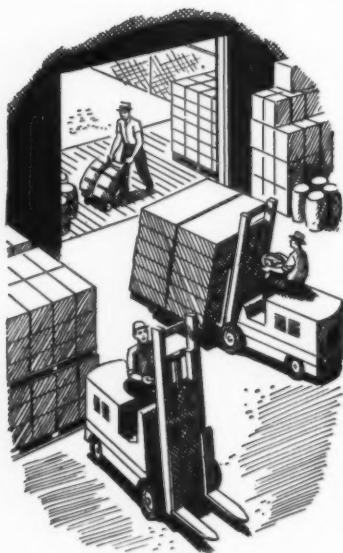
"If management expects engineers to be creative and to continue to have a tremendous impact upon the company's operations, then it must provide the proper background for them to perform," according to Sam Littlejohn, commercial vice president, General Electric Co., speaking at the same meeting.



Plastic Pipe Carries Water to Generating Plant

Corrosive well water will be conducted through Tenite butyrate plastic pipe, in one of the first in-

Complete **TRANSPORTATION** information to help you service clients



—get it quickly and without cost from Industrial Location Service of New York State.

Do you need current information on the availability of commercial transportation facilities in the Northeast? On rates or tariffs within, to or from this area? On schedules, terminals, and warehousing accommodations?

AUTHORITATIVE DATA IS AVAILABLE ON:

RAW MATERIALS: Cost and availability of all materials and supplies needed.

TRANSPORTATION: Availability of facilities, cost of assembling materials and distributing finished product between any given points.

MARKETS: Industrial and consumer market data.

LABOR: Availability, skills, and rates.

POWER AND FUEL: Character and cost at any point.

If so, write to the Industrial Location Service of the State of New York. We'll be glad to supply you with fully detailed, up-to-date information on rail, water, highway, and air transportation—or on any combination of these facilities.

We'll also send you free estimates on the cost of assembling materials at specified locations, and for distributing finished products to principal markets.

AVAILABLE BUILDINGS: Types, condition, facilities and terms. Confidential.

SITES: Availability, size, character, installed services; photos and maps. Confidential.

COMMUNITY SERVICES: A complete report on the facilities and attitudes of any community.

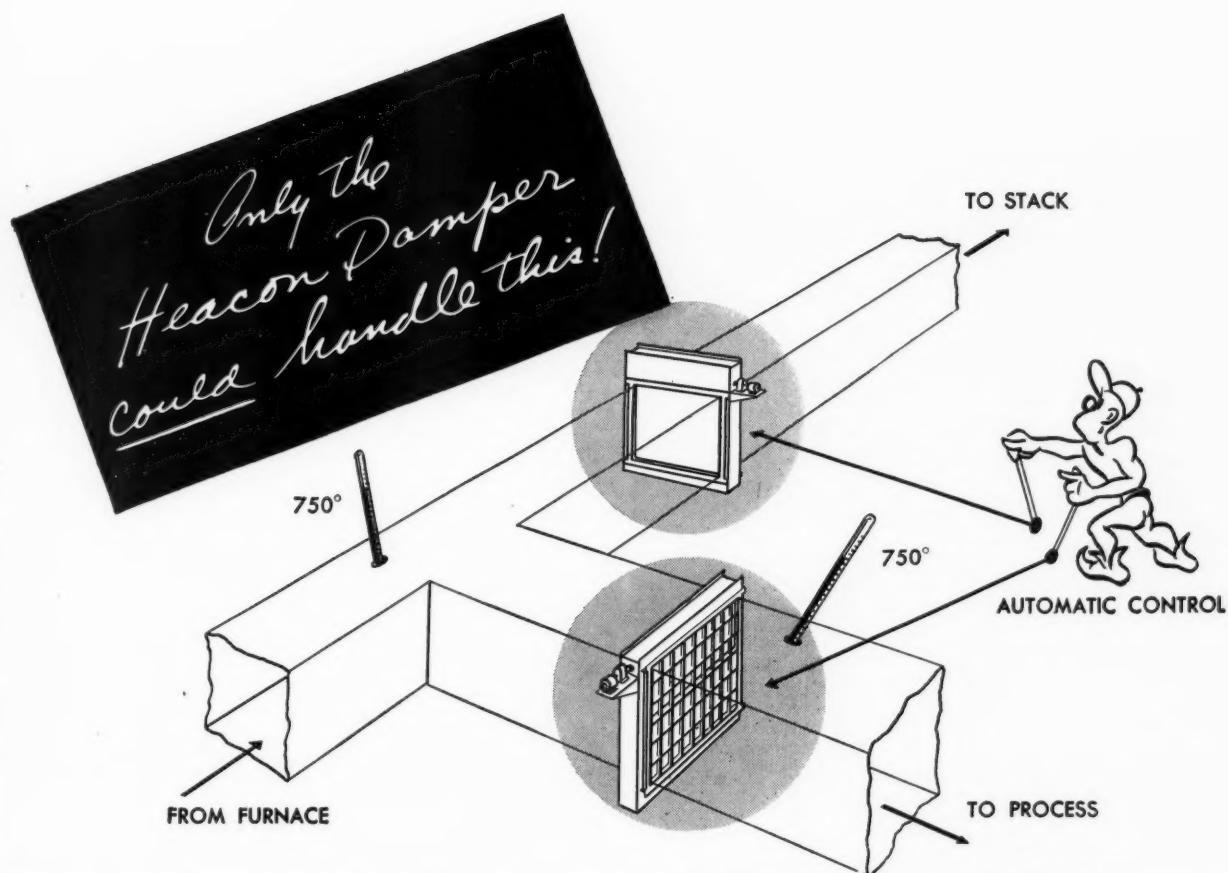
LAWS AND REGULATIONS: Full data on laws or regulations applying to any particular form of enterprise.

Industrial Location Service of New York State

"WE DON'T SELL SITES—WE MATCH NEEDS"

GET FREE BROCHURE: "Industrial Location Services." Also detailed physical map of New York State. Write New York State Department of Commerce, Room 833, 112 State St., Albany 7, New York.





Damper Automatically Controls Dangerously High Temperatures . . . Safeguards Expensive Processing From Contamination

In this installation the safety and success of a new process depends on two factors:

1. Automatic control of high temperatures.
2. Assurance of safety when temperatures approach danger zone.

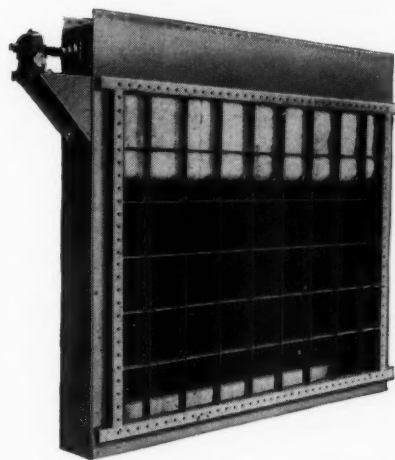
The process would be impossible without instantaneous and tight shut-off of heat to process and without automatic and dependable venting of heat to the stack. Damper leakage here could mean the loss of thousands of dollars in processing time and materials—not to mention the possible destruction of the plant and its personnel!

Temperatures and pressures had to be under quick, fool-proof control. That's why Heacon Dampers were specified. *Heacon is the only damper made that can assure the positive tightness and control so necessary in this installation!*

The Heacon Damper is a radical departure from conventional damper design. There are

no louvers to leak . . . no possibility of warpage. The greater the pressure the more tightly it seals!

Heacon Dampers are designed and constructed to meet practically any pressure or temperature specifications. Our engineers will be glad to discuss your problems with you.



THE THERMIX CORPORATION
GREENWICH, CONN.

Canadian Affiliates: T. C. CHOWN, LTD., 1440 St. Catherine St., W., Montreal 25; Quebec, 983 Bay St.; Toronto 5, Ontario, Canada

Plastic Pipe Carries Water

—Starts on page 64

dustrial installations of its kind, by Carolina Power and Light Company at their new Wilmington Steam Electric Generating Plant.

The quarter-mile-long pipe line will deliver water from its source to large tanks where the water is to be decarbonized.

As shown in the picture, page 64, 20-ft lengths of 3-inch diameter pipe were joined together by slip-sleeve couplings and solvent cement which provide, in effect, welded joints. It was not necessary to thread any of the couplings or pipe. The speed with which the butyrate pipe was joined, and the ease with which it was handled, due to its light weight, made it possible to install the pipe line in less than half the time it would have taken with metal. Material costs were also considerably lower. Red brass pipe, the material originally considered for the line, would have cost almost twice as much as the plastic.

The line will be operated at about 50 psi and is buried 30 in. below the surface of the ground.

The pipe installation was made under the supervision of Ebasco Services, Inc. Grinnell Corp. supplied the pipe which was extruded by Busada Manufacturing Co. Tenite butyrate plastic is marketed by Eastman Chemical Products, Inc., Kingsport, Tenn.



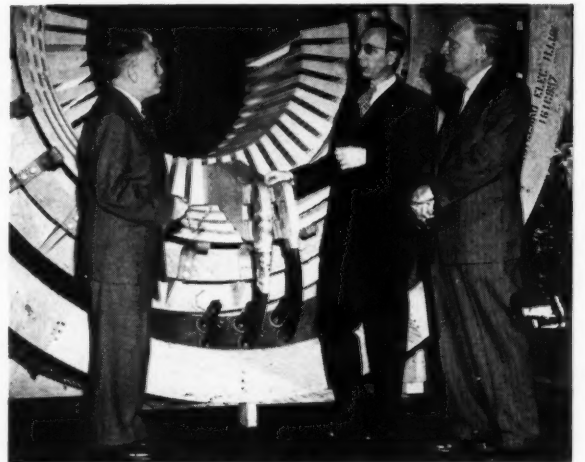
Second of Four Generators In Service at St. Clair Station

Electric power supply throughout Michigan's Thumb area was increased by 150,000 kw with the starting up of another steam turbine-generator at Detroit Edison's St. Clair Power Plant.

The new generator is the second of four to be placed in operation at St. Clair, bringing the station up to one-half its planned capacity. The two final units are slated to be producing power by next July, at which time the total generating capability of Edison's five-plant system will then be more than 3,300,000 hp.

In addition to the activity at St. Clair, Edison has already started work on a new station at River Rouge. There, foundation piling is being driven for a plant that will eventually house the two largest steam turbine-generators in the world.

The photograph shows Harry Pitcher (left), erection superintendent for Allis-Chalmers, manufacturers of the turbo-generator, and George Campan, St. Clair plant superintendent. General contractors for the project are United Engineers & Constructors, Inc.



Wooden Model Is Inspected

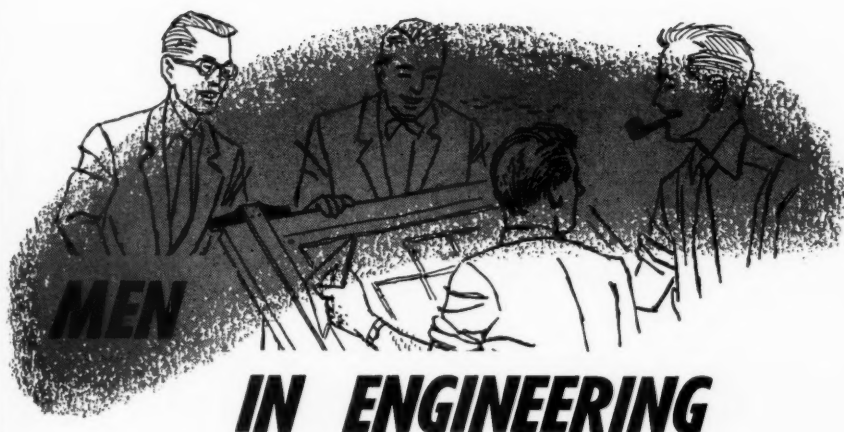
Inspecting the full-scale wooden model of a portion of the first large liquid-cooled generator in the history of the electrical industry are three executives of General Electric's Turbine Div.: Left to right, Glenn B. Warren, Charles E. Kilbourne, and H. Dana Taylor.

To be used for the Eastlake power plant of the Cleveland Electric Illuminating Co., the generator will have an operating capacity of 208,000 kw and will be an important step in development of generators of large capacity.

Census of Management Consultants Is Under Way

To overcome a deficiency in reliable statistical information about management consulting and consultants in the United States and Canada, the Association of Consulting Management Engineers, Inc. is undertaking a census of individuals and firms engaged in the profession.

One estimate sets the number of firms and individuals describing themselves as management consultants at 15,000, and another estimate places their total volume of business at about \$60 million annually. These figures have no valid statistical basis, according to the association, and the profession will have no reasonable index by which to measure its own growth until the census of consultants is complete in about two months.



IN ENGINEERING

★ Arthur D. Little, Inc., will open a western regional office in San Francisco early in 1954. Christian J. Matthew, a long-term employee of the company in Cambridge, will be in charge with Richard Newhall of San Francisco as an associate.

★ Charles A. Bigelow, vp and director of Stone & Webster Engineering Corp., after 22 years as west coast district manager and more than 45 years with the S & W organization, retired on December 31. N. M. Floyd on January 1 assumed management of the company's San Francisco of-

fice, and W. L. Sheets at the same time became the manager of the Los Angeles office.

★ Dr. Thomas K. Sherwood, professor of chemical engineering at Massachusetts Institute of Technology, has been retained by The Fluor Corp. as a consultant to its Research and Development Div.

★ Vincent T. Manas is now associated with the Plumbing Div. of J. A. Zurn Mfg. Co., as special consultant on plumbing engineering and in charge of sales in the Washington,

D. C. area. For the past several years he has been with the U. S. Department of Commerce during which time he coordinated what is now known as the "National Plumbing Code."

★ John W. Pennington, manager of the Metal Products Div., technical dept., of Koppers Co., Inc. will direct operations at the new mechanical development laboratory in Baltimore. Two other divisions of the company, the Engineering and Construction Div. and the Chemical Div. will furnish engineering services and field assistance in the building and operation of a styrene monomer plant in France for the Societe Hovilleres-Pechiney-Progil.



SLOAN ANSON SAXE

★ Gibbs & Hill, Inc. announce election of David B. Sloan as president, succeeding E. C. Johnson, who has resigned as president and chairman of the board. Edward H. Anson, is elected senior vp; John B. Saxe, vp and chief engineer; Barclay G. Johnson was appointed vp and engineering manager. Sloan, Anson, and Saxe now constitute the executive committee.

★ Dr. John Gaillard, until recently on the staff of the American Standards Association, and lecturer on industrial standardization at Columbia University, has become a management counsel, specializing in advice on national and international standardization problems.

★ Dr. Franklin D. Jones, widely-known in the agricultural chemical industry as the pioneer in modern weed killers through his patents on 2,4-D and 2,4,5-T, has joined the consulting staff of General Industries, Inc.

★ Sundberg-Ferar announces that the company, marking its twentieth anniversary this year, is expanding its services by the formation of an architectural division to be headed by Montgomery Ferar, registered architect. Joining the company as a staff member of this new division is Nathan Levine, formerly with Smith-Hinchman & Grylls, Inc., and Bankes Lightbourn & Assoc.

★ The historic John Scott Medal Award has been presented to Eugene J. Houdry in recognition of his

ATTENTION ENGINEERS!

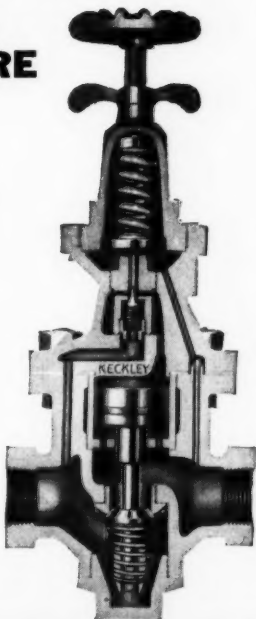
To get Precision Regulation and durability in **PRESSURE and TEMPERATURE REGULATORS** specify

KECKLEY

The Keckley line of regulators is designed for accuracy . . . service . . . low maintenance . . . easy accessibility. All of these add up to the highest degree of dependability you can get in this type of regulator. When you specify Keckley, you get one of the finest. Why not get the complete information today?



COMPLETE CATALOG 54-1 GIVES DETAILED INFORMATION ON KECKLEY STYLES, APPLICATIONS, SPECIFICATIONS AND FOR YOUR FREE COPY TODAY



O. C. KECKLEY COMPANY

400 West Madison

Chicago 6, Illinois

1914

40th Anniversary

1954

FROM THE HORN OF PLENTY AT BONNEY FORGE

**WELDOLETS
and
THREDOLETS**

**for Stainless
and
Alloy Piping**



STAINLESS

F 304 304 ELC F 316 F 347

CHROME MOLY

A 182 F 12 F 11 F 22 F 5

MONEL

WROUGHT IRON

ALUMINUM

AND OTHER ALLOYS

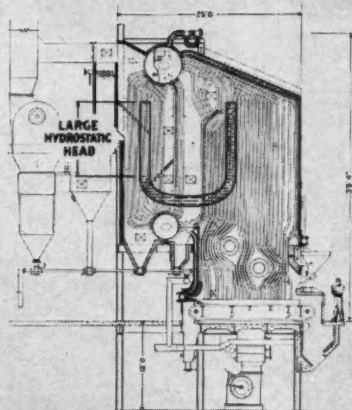
When constructing with alloy,
you're investing real money.
Assure performance-proved fittings
and save dollars by specifying
and using Weldolets and Thredolets
for 90° branch joints—large and
small, full size and reducing.

Distributors in Principal Cities

WELDING FITTINGS DIVISION

BONNEY FORGE & TOOL WORKS

ENG. DEPT., 370 GREEN STREET
ALLENTOWN, PENNSYLVANIA



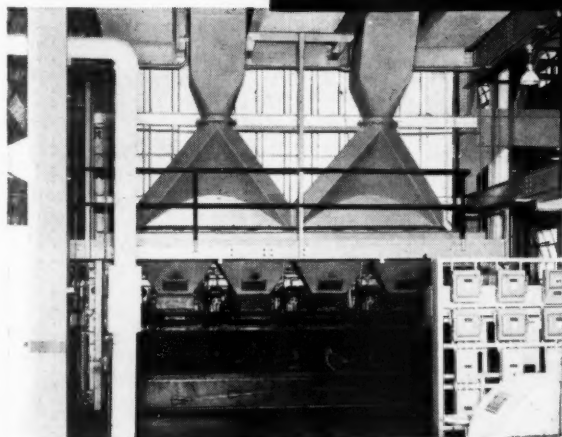
5. LARGE HYDROSTATIC HEAD



6. RAPID CIRCULATION



In addition to advantages described and illustrated in previous ads, BROS offers these two features which together help you maintain high watertube boiler efficiency consistently. Since you can't expect effective heat transfer from tubes to sluggishly moving water, BROS provides a larger hydrostatic head which circulates water at greatest practicable velocities. This rapid circulation means truly economical steam generation and cooler tube surfaces, an important safety factor.



This is a BROS 4-drum Watertube Boiler installation at a large midwestern utility. This plant generates electric power for consumers in the area.

Before you specify your next steam generating unit, talk to a man from BROS. He can tell you concisely what a BROS-designed watertube boiler offers you. Two of the points are illustrated above. Since 1888 BROS engineers have specialized in these features which make boilers deliver the most steam for the least money in a specified application. Many of these BROS advantages are exclusive. Find out how they can serve you!

Third in a series of ads describing BROS advantages, point by point. ADD THE ADVANTAGES . . . YOU'LL CHOOSE BROS!

BROS

Power Division: WM. BROS BOILER & MFG. COMPANY
1057 Tenth Ave. S. E., Minneapolis 14, Minnesota

DESIGNERS AND MANUFACTURERS OF 2, 3 AND 4 DRUM WATERTUBE BOILERS, SUPERHEATERS, AIR HEATERS, ECONOMIZERS, ACCESSORIES, AUXILIARIES, PLUS A FULL LINE OF HEAVY-DUTY STOKERS

Q-Partitions* help lower industrial fire damage



Fire prevention experts agree that one way to prevent costly industrial fires is to reduce large areas by the use of fire-resistive partitions. By doing so, fires that would tend to spread swiftly can be contained in a smaller area where they can be fought more effectively and brought under control. Robertson Two-Hour Fire Resistive Q-Partition is ideal for this purpose. Its installation will not interrupt production schedules . . . it is quick, clean, dry construction. It goes up while production goes on. And because it is clean and dry, there is no discomfort to employees, nor is there danger of dirt and dust injuring precision instruments or machines.

Robertson Q-Partition units arrive

at the job-site ready for installation, and require a minimum of field work, scaffolding and working space. *They are easily and quickly de-mounted and re-erected elsewhere,* giving a freedom of planning and layout not possible with other types of construction. They are good looking and have a high factor of light reflection. A Robertson Two-Hour Fire Resistive Q-Partition unit consists of two 18 gauge rolled steel fluted sections (each 1 7/8" deep) between which is sandwiched 1 1/2" (three 1/2" layers) of gypsum board. Each unit or panel is 24" wide and made in lengths up to 22'0". Robertson Q-Partitions are listed and approved by Factory Mutual Laboratories. Write for literature.

Robertson

***Two-Hour Fire Resistive**

Q-PARTITIONS*

a product of **H. H. Robertson Company**



2431 Farmers Bank Building • Pittsburgh 22, Pennsylvania
In England—Robertson Thain Limited, Ellesmere Port, Cheshire
In Canada—Robertson-Irwin Limited, Hamilton, Ontario

MEN

—Starts on page 68

achievements in the catalytic cracking of petroleum. The board of directors of city trusts in the Philadelphia Engineers Club presented the award.

★ J. A. Reidelbach, structural engineer, joins the staff of Timber Engineering Co.

★ Martin W. Chandler is appointed head of the Architectural Dept. of The Kuljian Corp., Constructors.

★ Anderson-Nichols and Co., Consulting Engineers, announce appointment of Joseph W. St. Andre as director of publicity. He was formerly associate editor of Factory-Management and Maintenance.

★ As chief engineering consultant to the Power Authority of the State of New York, Franklin J. Leerburger will coordinate the work of the designing and supervising engineers for the St. Lawrence River Power Project. He recently served as consultant to the Mutual Security Agency on problems relating to development of coal field and hydro-electric power in Turkey.



LEERBURGER

MEANY

★ The A. V. Smith Engineering Co., corrosion consultants, announces the appointment of J. J. Meany to vice president. In this capacity he will be responsible for corrosion studies made in the field.

★ Harvey K. Breckenridge has been appointed general manager of the Greek electrification program by Ebasco Services, Inc. Ebasco has been signed to a five-year contract by the Greek government to manage design and construction of a power system for the country, plus training of key Greek personnel. Ebasco also announces appointment of W. H. McInnis as manager, and M. G. Kennedy as assistant manager of the Sales, Marketing, and Public Relations Dept.

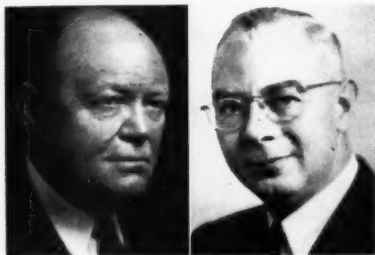
★ The American Institute of Consulting Engineers announces the following officers for 1954: Scott Turner, re-elected president, Richard E.

CONSULTING ENGINEER

Dougherty and Francis S. Friel, vice presidents; Leslie G. Holleran, re-elected secretary; George C. Diehl, re-elected treasurer.

★ Contract for the construction of an air-conditioned warehouse at the Esso Standard Oil Company's Baton Rouge refinery is awarded to Walter Kidde Constructors, Inc. The project is scheduled for completion in April.

★ Burnside R. Value, of Seelye, Stevenson, Value & Knecht, is re-elected president of the New York Association of Consulting Engineers for a second term. Other officers re-elected were V. L. Falotico, vice president; John M. Pryke, secretary; and Harry H. Bond, treasurer. Elected to the executive committee, which also includes the officers, were John F. Hennessy, of Syska and Hennessy; William H. Eipel, of Tuck & Eipel; and Darl Hunt, of Krey & Hunt.



VALUE

ROWAND

★ The Newcomen Medal, given only three times before in the history of the U. S. branch of The Newcomen Society, has been awarded to William H. Rowand, vp of The Babcock & Wilcox Co. by the Society and The Franklin Institute. His invention in 1936 of the cyclone steam separator led to his nomination for the medal.

★ Illinois Institute of Technology announces appointment of an advisory committee for the recently-created National Center of Education and Research in Dynamic Equipment Policy headed by Dr. Gerald J. Matchett (author of "The Range Finder," regular CE feature). The committee includes: John R. Bartizal, Clearing Machine Corp.; Geoffrey G. Beard, United Engineering and Foundry Co.; Robert C. Becherer, Link-Belt Co.; Dr. Pearce Davis, IIT; John T. Hodnette, Westinghouse Electric Corp.; Phelps Kelley, Miehle Printing Press and Mfg. Co.; William J. Kelly, William Kelly & Co.; Alexander Konkle, Council for Technological Advancement; Gordon Lefebvre, Cooper-Bessemer Corp.; William H. Morgan, Jr., Morgan Engineering Co.; Dr. John T. Rettaliata, IIT; Henry D. Sharpe, Jr., Brown & Sharpe Mfg. Co.; Harold B. Smith, Illinois Tool Works; Duncan J. Stewart, Barber-Colman Co.; and Thomas H. West, Draper Corp.

Understanding Corrosion:

when
OXYGEN

and WATER
get together

When free oxygen combines with atmospheric moisture or natural waters, the stage is well set for corrosive action. Controlling the degree and extent of that action are many related factors, variable in influence under differing circumstances.

The rate at which oxygen is transferred from atmosphere to a solution is, for example, directly proportional to the amount of exposed surface area of that solution, while the corrosion rate of immersed metal is, in turn, proportional to the oxygen concentration of the solution. Therefore, with all other factors stabilized, a reduction in exposed surface area will slow the oxygen-solution process, thereby greatly retarding corrosion.

How deeply metal is immersed, particularly in a quiet solution, is another determinant of corrosive action in which dissolved oxygen is the governing factor. Oxygen satura-

tion, highest at and near the surface, diminishes with increasing depth as convection currents become less active. Corrosion at and immediately below the surface of a liquid is therefore far more severe than that encountered at greater depths.

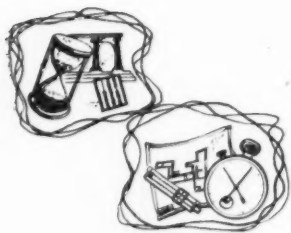
These and other variables that combine to produce a given corrosion problem must be evaluated in any attempt to reach an effective and practical solution. Such evaluation, based on thirty-five years' corrosion-control experience, is standard Dampney procedure. That is why your specification of a Dampney Coating assures you so much more — protection you can depend upon to meet not only standard industrial service requirements but your specific equipment-operating needs. For data on Dampney Protective Coatings and their place in your corrosion-control program, write

MAINTENANCE
FOR METAL

DAMPNEY
COMPANY

158-1

HYDE PARK, BOSTON 36, MASSACHUSETTS



Management Engineering

—Starts on page 41

tem departments, organization planning departments, and top-level management research departments. An example of a top-level department of this kind is the management consultant services division within the General Electric Company organizational structure.

Consultants Increase

The growth in complexity and size of our industrial and business economy has been accompanied by a considerable increase in the number of qualified management consulting firms and by an expansion of the kinds of services which they are in position to supply. In the last 40 years, rapid strides have been made in the art of management. Based largely upon the scientific methods so ably developed by the pioneer industrial engineers — Taylor, Emerson,

Gantt, Gilbreth — and those who followed them, every phase of management has been improved and refined. New methods have been developed to make possible the orderly and successful conduct of the nation's increasingly large enterprises.

Kinds of Service

The kinds of management engineering services offered have increased greatly since the early days when they had to do mostly with factory production problems. This expansion was perfectly natural as it became clear that the methods of scientific management were generally applicable to all kinds of enterprises as well as to the factory.

Many management consulting firms at the outset offered only certain specialized services such as those concerned with factory production methods, wage incentives, market research, or personnel. They gradually added other services until eventually they were set up to handle effectively almost any kind of a management problem a client might have. To accomplish this expansion meant adding various kinds of specialists to their staffs.

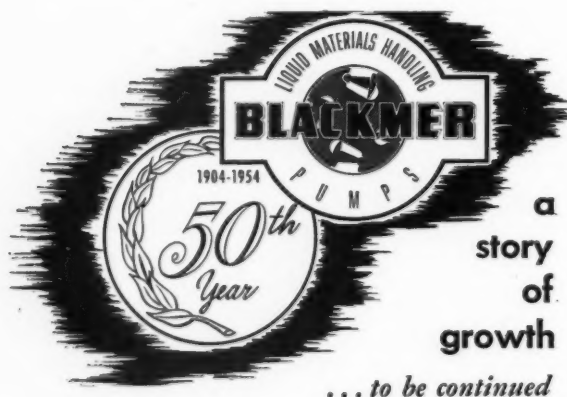
Areas of Enterprise

The principal areas of enterprise into which management engineering has penetrated are numerous: manufacturing concerns of all kinds, retailers and wholesalers, service organizations, financial institutions, insurance companies, trade associations, railroads, public utilities, airlines, hospitals and similar institutions, educational institutions, social service organizations, the federal government, state and municipal governments, foreign governments, and private enterprises in foreign lands.

There is ample evidence to indicate that management consultants have been called in to do important work in numerous areas of our economy, and that the use of their services is growing. The extent of their services is shown by the fact that the estimated yearly billing of the consultants who belong to the Association of Consulting Management Engineers totals about \$35 million. It is further estimated that the billing of all well-established, qualified management engineering firms in the United States runs to well over \$50 million a year at the present.

Future Growth

And what of the future? It appears certain that our civilization and its economy will continue to increase in complexity, that the task of management will grow in importance, and that management will meet increasingly difficult problems. It seems reasonable to expect also that management will increasingly come to appreciate, and make use of, competent management consultants to assist them in meeting and solving important and troublesome problems of modern enterprise.



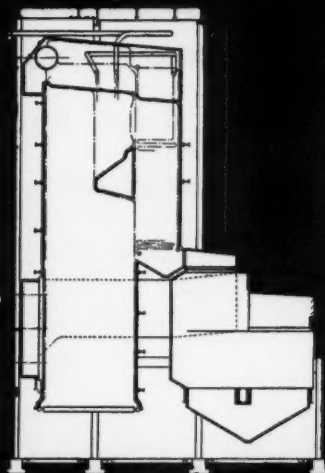
Blackmer's growth has been earned by the development and manufacture of products backed by 50 years of constant laboratory and field research. These products include industrial bulk pumps, truck pumps, hand pumps, strainers and fluid motors. Blackmer's advanced design, smooth operation, economy, and flexibility of use . . . have been performance proved throughout the last half century. Wherever liquids are handled, Blackmer pumps are known for quality, dependability and record durability. And now, new products soon to be announced promise a new standard of performance. Our engineers can solve your liquid materials handling problems . . . write for details today!

 **BLACKMER**
Industrial Hand and Truck Pumps, Strainers, Pressure Control Valves
BLACKMER PUMP COMPANY, GRAND RAPIDS 9, MICH.
DIVISION SALES OFFICES — NEW YORK • ATLANTA • CHICAGO
GRAND RAPIDS • DALLAS • WASHINGTON • SAN FRANCISCO
See Yellow pages for your local sales representative

RIGHT IN THE HEAT OF THINGS

in Power Plants

... you'll find economy-minded B-L boiler enclosures in power plants all over the country. Size poses no problem: B-L engineers them all from small HRT settings to huge 10-story jobs like the one illustrated.



in Chemical Plants

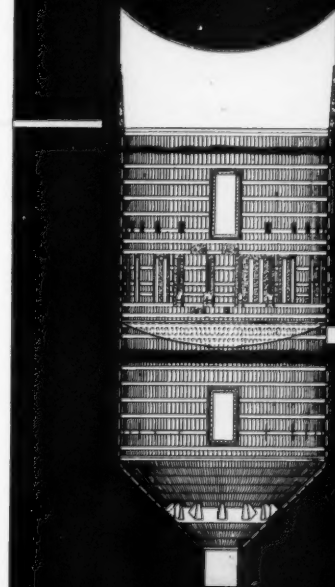
... Bigelow dryer furnaces deliver a tremendous volume of hot gases—as much as 93,000,000 BTU's—at predetermined temperatures to rotary dryers. Furnaces process coal, sugar, salts, grain—any product from which moisture must be removed.



in Oil Refineries

... B-L offers a complete, one-source service of engineering, materials, and erection help for castable regenerators and pressure vessels of all kinds. Construction can be either castable, tile or a combination of the two.

yes, and in the metal, glass, cement and sugar industries (others, too!) B-L enclosures are right in the heat of things. Write today for complete information.



BIGELOW-LIPTAK Corporation

and Bigelow-Liptak Export Corporation
2550 W. GRAND BLVD. • DETROIT 8, MICHIGAN

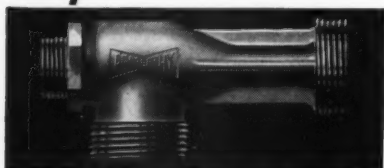
UNIT-SUSPENDED WALLS AND ARCHES

In Canada: Bigelow-Liptak of Canada, Ltd., Toronto, Ontario

ATLANTA • BOSTON • BUFFALO • CHICAGO • CINCINNATI • CLEVELAND • DENVER • HOUSTON • KANSAS CITY, MO. • LOS ANGELES • MINNEAPOLIS • NEW YORK
PITTSBURGH • PORTLAND, ORE. • ST. LOUIS • ST. PAUL • SALT LAKE CITY • SAN FRANCISCO • SAULT STE. MARIE, MICH. • SEATTLE • TULSA • VANCOUVER, B.C.

LOW
COST...
COMPACT
TROUBLE-
FREE..

PENBERTHY JET PUMPS IN A FULL RANGE



Hydraulic Ejector—for lifting, elevating and blending of liquids and slurries.



Steam or Air operated Ejector—for a wide range of operating conditions.



Special Jet Pump—for handling corrosive chemicals.

● Consider the simplicity of the jet pump. It uses steam, water, air or gas under pressure to transfer or mix, without clogging, *any liquid which will flow through pipes*. It has no moving parts or packing glands. Needs no lubrication or maintenance. It's practically noiseless, costs little and is compact.

Penberthy jet pumps are being used in standard and unusual applications. They are also made to withstand corrosion, contamination and high temperatures.

Penberthy can help you save time and money, increase the efficiency of your operation. Write for Bulletin No. 512 which details the complete line of jet pumps by Penberthy.

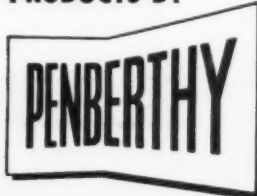
Established 1886

PENBERTHY INJECTOR COMPANY

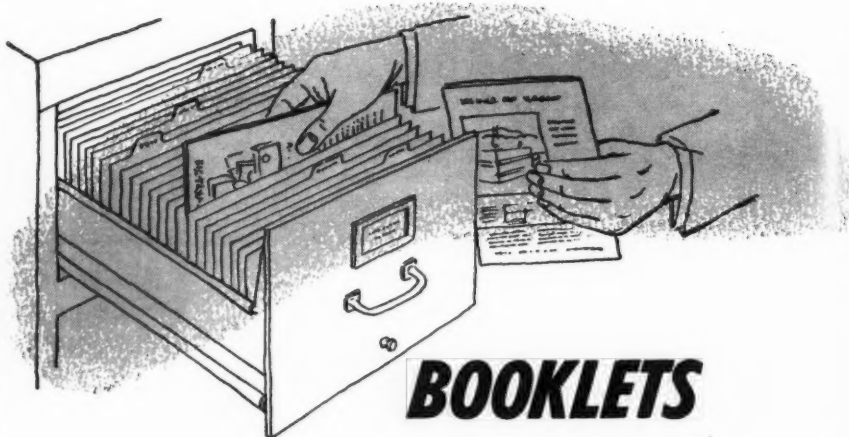
Division of the Buffalo-Eclipse Corporation

1242 Holden Ave., Detroit 2, Michigan

**There's Certain satisfaction in
PRODUCTS BY**



- GAGES
- EJECTORS
- EDUCTORS
- EXHAUSTERS
- SYPHONS
- ELECTRIC SUMP PUMPS
- CYCLING JET PUMPS
- INJECTORS



BOOKLETS

Personal copies of booklets can be obtained by writing directly to the manufacturers

CONSTRUCTION FEATURES of various industrial belts, with recommended usage, are described and illustrated in 33-page brochure S-35. Special sections are devoted to oilproof, textile, lumbermill, and agricultural belts. Method of making Plylock belt joint, said to eliminate the cause of nearly all belt failures, is discussed. B. F. Goodrich Corp., Dept. CE, Akron, Ohio.

FLEXIBLE COUPLINGS which never require lubrication are shown in 19-

page bulletin 1009. Valuable engineering data for each type of coupling are given in table form along with drawings and application recommendations. Two more tables give conversion data for varying or pulsating load and for horsepower to torque. Lovejoy Flexible Coupling Co., Dept. CE, 4843 W. Lake St., Chicago 44, Ill.

Model "R" Aeroturn dust collector is described in this four-page folder as the first major advancement in

Why they buy NEFF & FRY Storage Bins

In the photograph you see how the diagonal-ended staves of a Neff & Fry Storage Bin are laid up. They are grooved and beaded to lock together. Each course is encircled with as many galvanized steel rods as needed to withstand the thrust of the load.

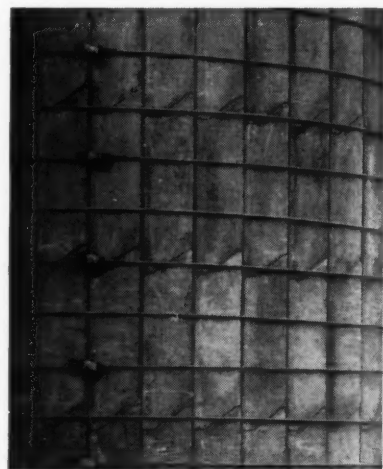
Our bins (often termed silos or tanks) are used by scores of America's leading companies for handling more than 80 kinds of flowable bulk materials; notably, cement, coal, clay, grain, gravel, ore, sand, wood chips.

The reasons:

Formed under tremendous hydraulic pressure, the staves are rocklike in strength and density. They do not spall, rust, or burn.

Since the walls are only 2½" thick, the bins have great capacity in relation to outside diameter; no wasted ground area.

Despite the thin walls, the structures have sufficient load-bearing ability to carry heavy superstructures without additional supports.



Our wide experience enables us to make valuable suggestions regarding materials handling systems and equipment.

If you want to invest a few minutes in mighty profitable reading, ask for our folder, "Bins with the Strength of Pillars."

THE NEFF & FRY CO.

302 Elm St., Camden, Ohio

NEFF & FRY ➔ **SUPER-CONCRETE STAVE
STORAGE BINS**

BOOKLETS —Starts on page 74

dust collector design since the introduction of Hersey type reverse-air-jet filters. Advantages and operation of the units is explained. A cross-sectional drawing points out the special construction features. *Turner & Haws Engineering Co., Inc., Dept. CE, West Roxbury, Mass.*

"COOLING TOWER Wood Maintenance," 13-page bulletin TSC-302, is a summary of work done and conclusions reached to date as a result of a joint study on the subject by the Cooling Tower Institute and the California Redwood Association. Photographs of several typical samples of degraded material have been included as a visual aid to users and manufacturers in their early detection of cases of deterioration in the several forms in which it may appear. *Cooling Tower Institute, 444 Emerson St., Palo Alto, Calif.*

STEAM TRAPS which vent air from steam units eight times faster than ordinary inverted bucket traps are described in four-page folder 1153. Complete buying information on these Super-Silvertop Heat-Kwik traps includes condensate capacities, sizes, weights, and prices. A short description of other products manufactured by the Steam Specialties Div. of this company is also given. *V. D. Anderson Co., Dept. CE-H, 1935 W. 95th St., Cleveland 2, Ohio.*

By COMBINING automatic spinning with drawing, the design engineer can secure an almost unlimited variety of designs in a wide range of metals according to 20-page booklet SP-100. Included are discussions of radar antenna systems, their design, development and fabrication; jet engines, new fabrication methods for major components of engines; thermodynamics, design, development, and fabrication of equipment to operate on advanced theories; guided missiles and new fabricating techniques for airframe members; titanium, the development of new welding, forging, forming, and spinning techniques for this hard-to-work metal. *Advertising Dept. CE, I-T-E Circuit Breaker Co., 19th and Hamilton Sts., Philadelphia 30, Pa.*

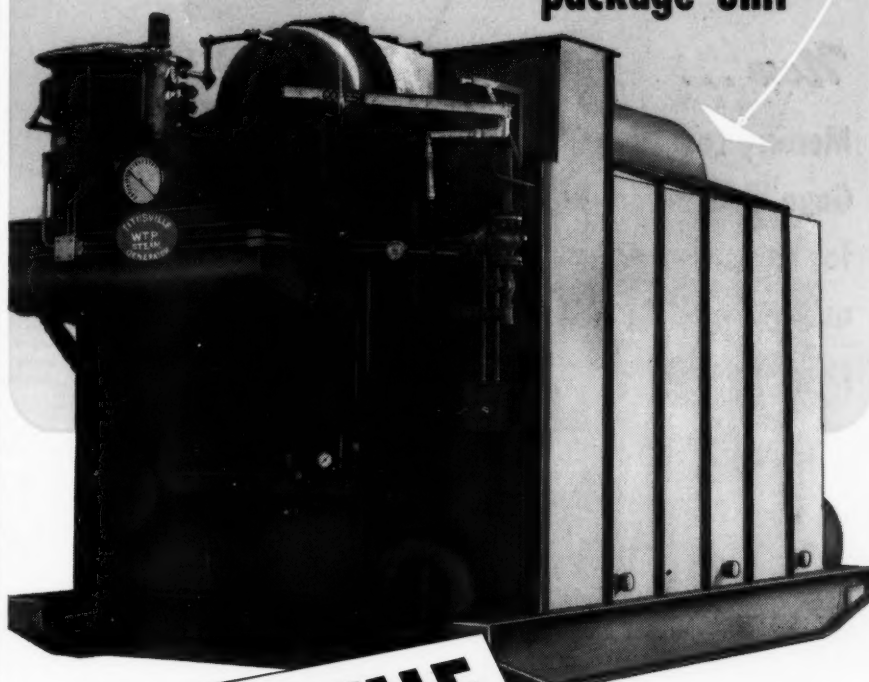
INDUSTRIAL ELECTRIC heating applications and methods are described in 32-page booklet, "101 Ways to Apply Electric Heat." Illustrated case histories show experience-tested ways to apply metal-sheathed Chromalox electric heating units in various industrial jobs. Physical aspects of installation are shown along with a description of the problem, solution, and advantages obtained.

UP TO

30,000 pounds of

Steam

**per hour from this modern TITUSVILLE
package unit**



TITUSVILLE

TYPE WTP

Water Tube

STEAM GENERATOR

The most steam produced in the least space—that's the measure of efficiency and simplicity of design and performance in our modern WTP Steam Generator. This water tube package unit is shop-assembled, furnished in a range of capacities from 7500 pounds of steam per hour, and is adapted for firing with all oil and gas fuels and their combinations. Write for Bulletin B-3275 on this compact steam package, today!



A division of

**Struthers
Wells**

**THE TITUSVILLE
IRON WORKS COMPANY**
TITUSVILLE, PENNSYLVANIA

Manufacturers of a COMPLETE LINE OF BOILERS FOR EVERY HEATING AND POWER REQUIREMENT

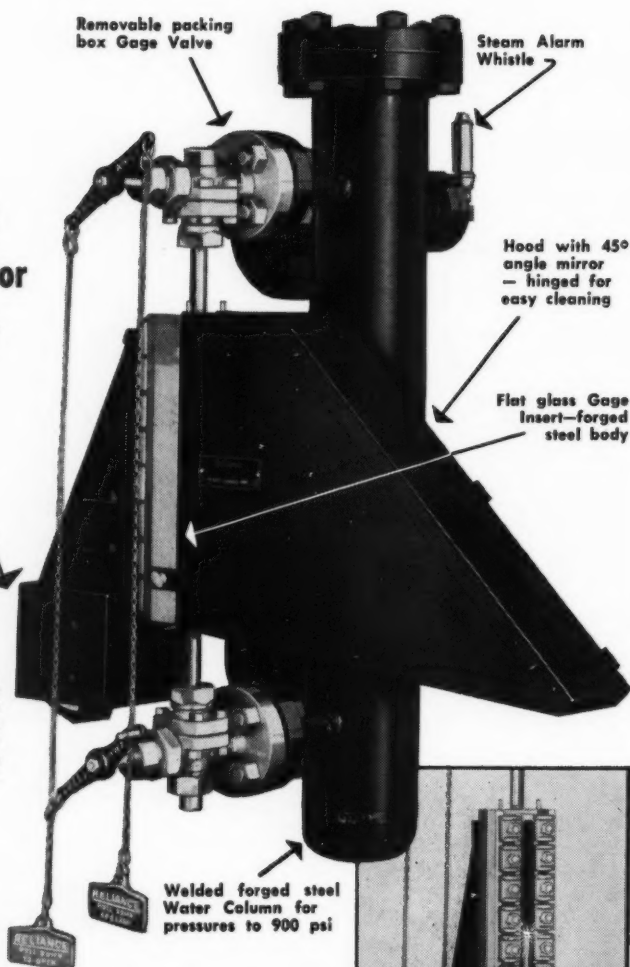
Your principal source

for modern Water Columns and Water Gage Equipment-

Reliance

New...
**Mercury Lamp
Gage Illuminator
for extra-clear
and distant
reading**

Recommended for
conditions where gages
are 40 ft. or more from
operating level, or for
extra bright meniscus
image. See cut at right.



Reliance Water Columns for any working steam pressure assure you the utmost in dependability. High and low water level alarms are available on columns for pressures to 900 psi. Standard and special columns and complete safety gage equipment are made for pressures to 2500 psi.

The Reliance Gauge Column Company
5902 Carnegie Avenue Cleveland 3, Ohio

The name that introduced safety water columns....in 1884

Reliance

BOILER SAFETY DEVICES

BOOKLETS —Starts on page 74

A section is devoted to far-infrared heating, showing 28 typical uses for this new method. *Edwin L. Wiegand Co., Dept. CE, 7529 Thomas Blvd., Pittsburgh 8, Pa.*

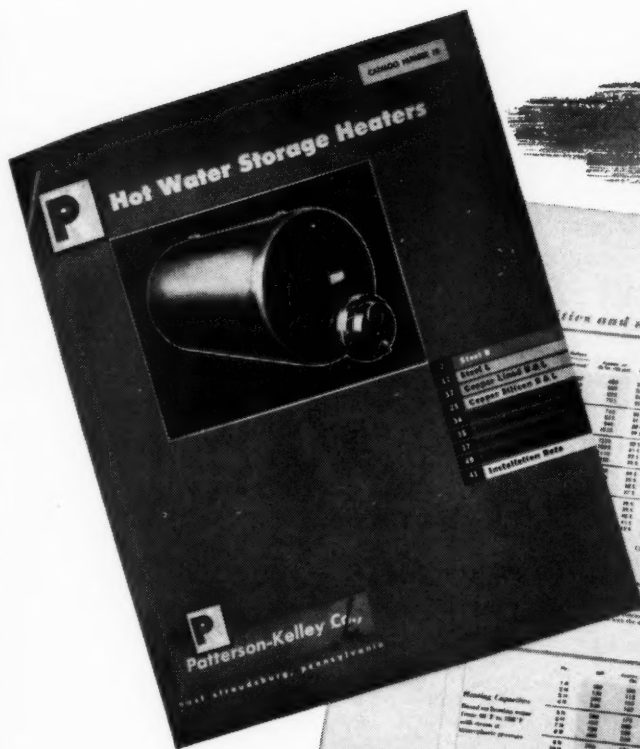
MODERN MULTIPLE action machines in high speed production require a safe, dependable means for repeated quick closing and opening of the electrical circuits controlling the sequence of operations. Combined bulletins 501 and 502 describe magnetic contactors for this use. The four standard types of controls are explained: remote; local; selector switch; and three-wire thermostat. Tables list dimensions and weights. *Federal Electric Products Co., 50 Paris St., Dept. CE, Newark 5, N. J.*

PROMPTED BY RESULTS of a recent market analysis, together with first hand observations in the field, the Architectural Products Div. of this company has published a brochure which should clarify any questions concerning their radiant panel heating, cooling, and acoustic control ceiling. The booklet includes a brief of twelve important advantages of this completely self-contained ceiling; a clear-cut departmentalization of components, and their applications; performance characteristics; design procedure; layout procedure; how to estimate; and the installation short cuts which result in important savings. *D. W. Day, v p, Burgess-Manning Co., Architectural Products Div., Dept. CE, 5970 Northwest Hwy, Chicago 31, Ill.*

FEATURED in the winter 1954 "Also Products Review," is an article outlining the accomplishments of the heat-exchanger research program conducted since 1946 at the University of Delaware. Heat-transfer coefficients and pressure drop for various tube spacings and arrangements are discussed along with the effect of baffling on various flows. This section also includes a complete bibliography of papers on heat transfer and fluid flow. Other articles describe the jet-engine exhaust gas cooler installed at the new Naval Air Turbine Test Station, Trenton, N. J., and casing head gas processing and storage at the Diamond M-Sharon Ridge gasoline plant. *Public Relations, Dept. CE, the American Locomotive Co., Schenectady 5, N.Y.*

HORIZONTAL AND VERTICAL heaters in steel, copper lined, copper-silicon, cement lined, clad and galvanized construction, as well as the low-flow design are each cataloged as to weights, dimensions, construction details, and capacities — with conversion tables, in 48-page catalog

get the facts



and figures

on hot water storage heaters

A new edition of the most complete reference catalog of its kind, covering all types, sizes and styles of **p-k** hot water storage heater equipment. A reference work needed by every architect, engineer, contractor or user of hot water for process or service. Because of its size, cost, and importance, will you please request your Free copy on your company letterhead.



the **Patterson-Kelley Co., inc.**

1720 Burson Street, East Stroudsburg, Penn.

101 Park Avenue, New York 17 • Railway Exchange Building, Chicago 4 • 1700 Walnut Street, Philadelphia 3 • 96-A Huntington Avenue, Boston 16 • and other principal cities.

FEBRUARY 1954

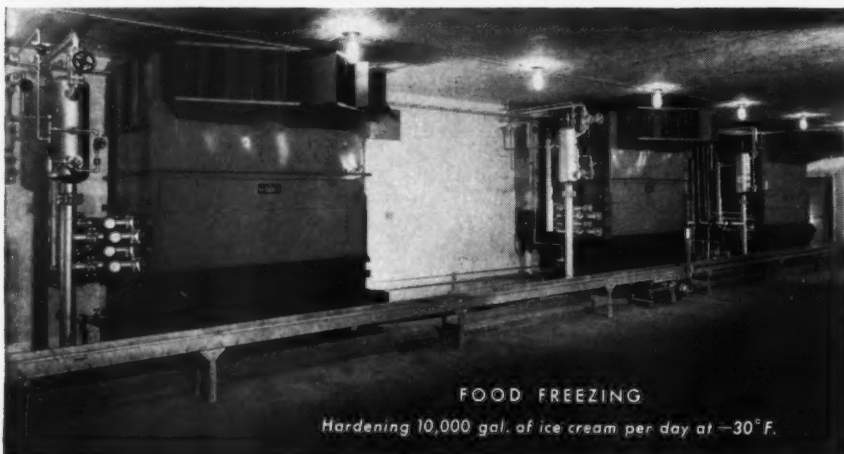
NIAGARA "No-Frost"

**SUCCESSFUL
IN BIG
INSTALLATIONS**



PRECOOLING

2 Niagara Spray Coolers pre-cool 3500 boxes of pears per 24 hours—total storage capacity 40,000 boxes.



FOOD FREEZING

Hardening 10,000 gal. of ice cream per day at -30°F .



FROZEN FOOD STORAGE

Room 80 ft. x 135 ft.—Temperature -5°F .

NIAGARA "No-Frost" gives you extra capacity and better operation. It improves quality, especially in foods, where it brings the product to correct temperature faster and holds it without fluctuation. It saves money for you in the cost of power and labor. With Niagara "No-Frost" there is never any "de-frosting" loss of time or temperature rise.

Write for Bulletin 105

NIAGARA BLOWER COMPANY

Dept. CO, 405 Lexington Ave.
New York 17, N. Y.

Sales Engineers in Principal Cities
of U. S. and Canada

BOOKLETS —Starts on page 74

18. Piping diagrams are given for high and low pressure steam systems. Also included is a step-by-step guide for setting up and connecting a storage heater. Listed also are average water requirements of typical hot water fixtures in various types of buildings. *The Patterson-Kelley Co., Inc., Dept. CE, 388 Warren St., East Stroudsburg, Pa.*

REPUTED TO BE the most comprehensive catalog ever produced on pressure gages, gage accessories, and gage engineering information, 125-page bulletin is supplemented by numerous photographs, line drawings and dimensional drawings. It is sectionalized by product lines and includes a contents page, a numerical index, an alphabetical index, and selector tables for both the Ashcroft Duragauges and Ashcroft Quality Gauges. *Manning, Maxwell & Moore, Inc., Dept. CE, Stratford, Conn.*

POWERMASTER packaged automatic boilers in seventeen sizes from 15 through 500 hp for steam process as well as steam and hot water heating service are described in a four-page folder. It lists the advantages of packaged automatic boilers contrasted with equipment of conventional design. The firing equipment for light and heavy oils as well as gas is described in this company's Vori-flow air-atomizing oil burner and pre-mix gas burner designs. Several installation photographs show various fuel firing arrangements. *Orr & Sembover, Inc., Dept. CE, Morgantown Rd., Reading, Pa.*

ENGINEERING Brochure, "Case Studies," describes a variety of successful applications of conventional warm air space heaters to the job of industrial process drying. Featuring installations for curing rubber, and drying ceramic, paper, lumber, and woven products, the studies explain the methods followed in applying the heaters to different types of drying systems. *Dravo Corp., Dept. CE, 1203 Dravo Bldg., Pittsburgh 22, Pa.*

OF PARTICULAR INTEREST to architects and building engineers, this 48-page pamphlet of fire resistance ratings is a revision of Appendix A of National Board of Fire Underwriters' National Building Code. It contains a number of tables on fire resistance ratings of beam, girder and truss protection; ceiling constructions; column protections; floor and ceiling constructions; roof constructions, and walls and partitions. *National Board of Fire Underwriters, 85 John St., Dept. CE, N. Y. 38.*

consulting engineers' calendar

Date	Sponsor	Event	Location
Feb. 14-18	American Institute of Mining and Metallurgical Engineers	Annual Meeting	Hotel Statler New York, N. Y.
Feb. 15-19	American Society of Civil Engineers	Convention	Biltmore Hotel Atlanta, Ga.
March 7-10	American Institute of Chemical Engineers	Meeting	Hotel Statler Washington, D. C.
March 10-12	American Society of Mechanical Engineers	International Meeting	Del Prado Hotel Mexico, D. F.
March 15-19	National Association of Corrosion Engineers	10th Annual Conference	Muehlebach Hotel Kansas City, Mo.
April 15-19	American Institute of Electrical Engineers	Southern Textile Conference	Georgia Tech. Atlanta, Ga.
April 26-30	American Society of Tool Engineers	Industrial Exposition	Convention Center Philadelphia, Pa.
April 27	Association of Consulting Chemist and Chemical Engineers	Symposium-Banquet	Hotel Belmont Plaza New York, N. Y.
May 4-7	American Welding Society	Spring Meeting	Hotel Statler Buffalo, N. Y.
May 10-12	Compressed Air and Gas Institute	Spring Meeting	The Homestead Hot Springs, Va.
May 16-19	American Institute of Chemical Engineers	Summer Meeting	Springfield, Mass.
May 17-20	Basic Materials Exposition and Conference	2nd Annual Exposition	Amphitheater Chicago, Ill.
May 23-28	American Water Works Association	National Convention	Seattle, Wash.
June 14-19	American Society of Civil Engineers	Convention	Chalfonte-Haddon Hall, Atlantic City
June 20-24	American Society of Mechanical Engineers	Semi-annual Meeting	William Penn Hotel Pittsburgh, Pa.
June 20-25	American Institute of Chemical Engineers	Nuclear Engr. Conference	University of Mich. Ann Arbor, Mich.
June 21-25	American Institute of Electrical Engineers	Summer General Meeting	Los Angeles, Calif.
June 28-30	American Society of Heating and Ventilating Engineers	Semi-annual Meeting	New Ocean House Swampscott, Mass.
July 13-15	Western Plant Maintenance Show	Conference and Exposition	Pan Pacific Bldg. Los Angeles, Calif.

PROFESSIONAL LISTINGS

DE LEUW, CATHER & COMPANY CONSULTING ENGINEERS

Transportation, Public Transit and
Traffic Problems
Industrial Plants
Railroads
Subways
Power Plants
Grade Separations
Expressways
Tunnels
Municipal Works
150 N. Wacker Drive
Chicago 6, Ill.
79 McAllister Street
San Francisco 2, Cal.

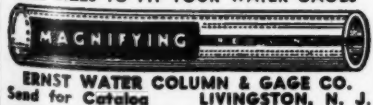
Capitol Engineering Corporation Engineers — Constructors — Management Design and Surveys Sewage Systems Planning Bridges Roads and Streets Water Works Airports Dams

EXECUTIVE OFFICES
DILLSBURG, PENNSYLVANIA
Washington, D. C.
Dallas, Texas
Pittsburgh, Pa.
Paris, France

SAMUEL F. TURNER

Ground-Water Geologist and Engineer
Advisory Service to the Consulting Field.
Water supply investigation and reports.
Well locations and foundation surveys by geology
and geophysics.
Well development and pumping tests.
Drill sample description and testing.
350 East Camelback Road
Phoenix, Ariz.

GAGE GLASSES AND High Pressure Rubber Gaskets ALL SIZES TO FIT YOUR WATER GAGES



ERNST WATER COLUMN & GAGE CO.
Send for Catalog
LIVINGSTON, N. J.

DAVID C. PFEIFFER

Consulting Engineer

Mechanical

Electrical

6819 HILLCREST

DALLAS, TEXAS

Got GARBAGE COOKING Problems?
Hapman-Dutton offers help, engineering
consultation and equipment to meet State
Laws on cooking garbage for hogs. Write,
wire, call. Phone 3-1675.

HAPMAN-DUTTON CO.
630-D Gibson St.
Kalamazoo, Mich.

THIS NEW BOOK

will actually show you how to design, construct, and operate *more efficient* temperature measurement installations.



TEMPERATURE MEASUREMENT in ENGINEERING

Volume I

By H. D. BAKER, Columbia University; E. A. RYDER, Pratt & Whitney Aircraft; and N. H. BAKER, Columbia University

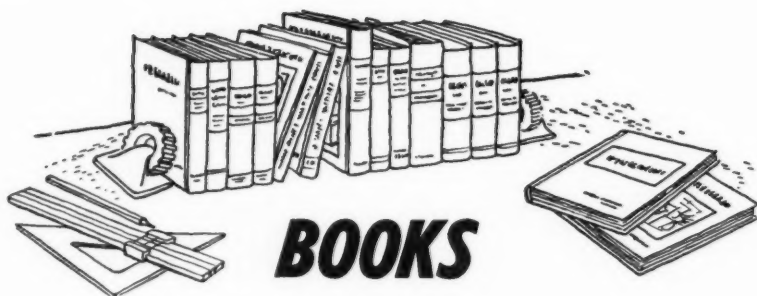
1953. 179 pages. \$3.75

All the facts are presented in this convenient, non-mathematical treatment of temperature measurement, stressing thermocouples. Unlike any other work, it provides:

- a complete list of the techniques to be employed
- proven methods of analysis
- a survey of previous designs
- specific application information
- explanation of the meaning of the term: "temperature"
- a catalogue of special materials
- methods by which pitfalls and errors can be avoided
- complete design-calculation procedures
- a full listing of the types of instruments used in measurement

This book stands ready to answer your temperature-measurement problems *now*.

Published by
JOHN WILEY & SONS, Inc.
mail order to
CONSULTING ENGINEER
420 Main St., St. Joseph, Mich.



TO ORDER BOOKS

As a readers' service, CONSULTING ENGINEER will order reviewed books or any other technical volumes you need. In ordering books, give title, author, and publisher and enclose check or request books COD. We will also suggest titles of books on any technical subject and order for you at regular publishers' prices.

STRESS CONCENTRATION DESIGN FACTORS, R. E. Peterson, 155 pages; John Wiley & Sons, 1953, \$8.50

*Reviewed by Edward R. Estes, Jr.
 Department of Engineering
 University of Virginia*

Stress concentrations due to abrupt changes in cross-section are of considerable importance in machine and structural design. The twentieth century has seen many of the problems solved by theoretical analysis. In recent years the rapid advance of experimental stress analysis has been responsible for the solution of some of the more difficult cases in addition to verifying those previously solved.

The author has gathered these widely scattered solutions and presented them in an excellent volume. The design engineer has at his finger tips the solution to almost any stress concentration problem encountered. Where the original solutions were in the form of equations or small graphs, all solutions in this book are on 7" x 9" graphs with adequate grids requiring little interpolation.

The first chapter provides an introduction to the design relations for steady and alternating stress. There is a brief but clear explanation of the various strength theories.

The succeeding chapters present the stress concentration factors for grooves, notches, shoulder fillets, holes, gear teeth, and keyways. These concentrations are considered in bars, shafts, and plates subjected to tension, bending, and torsion. Graphs are based on investigations by the theory of elasticity, photoelasticity, strain gages, membrane analogy, and electric analogy. Explanations of the charts appear at the first of each chapter.

There is an excellent bibliography

for additional reference and further study of any particular phase of stress concentration. The "edge-finder" combined with the ring binder make this a convenient handbook for design work.

ALSO AVAILABLE

REPORT ON OIL AND GAS ENGINE POWER COST, 1953, American Society of Mechanical Engineers, 37 pages, \$2.50 (\$2.00 for ASME members). The 25th successive annual report, this book contains data on 137 different plants. The material is broken up into three tables: Plant Cost Table; Cost by Years (for plants reporting for successive years); and Detailed Operating Information.

INTRODUCTORY CIRCUIT THEORY, by Ernst A. Guillemin, John Wiley & Sons, Inc., 550 pages, \$8.50. Methods of steady-state and transient circuit analysis, as well as the basic concepts essential to synthesis procedures are presented in this book. It provides the tools and concepts, graphical interpretations and computational aids necessary for the understanding of advanced research in network theory.

AMERICAN STANDARD PRACTICE FOR STREET AND HIGHWAY LIGHTING—Illuminating Engineering Society, 32 pages, \$.50. Liberally illustrated with tables, charts, and drawings, the new Standard Practice presents the underlying principles involved in the layout and design of good street and highway lighting. The booklet classifies as to type: highways; vertical and horizontal luminaire light distribution, complete

with detailed drawings; and design of street and highway lighting, including luminaire mounting heights and positioning. Information on situations requiring special consideration is covered.

AIR POLLUTION ABATEMENT—GAS AND VAPOR, Manufacturing Chemists' Association, 30 pages, \$.60. This 10th chapter of the Air Pollution Abatement Manual treats methods of abatement of gases and vapors. Some of these are: waste dispersal by the use of stacks; employing absorbers or scrubbers which, in effect, soak up the gas or vapor; incineration; catalytic combustion; and adsorption, which is the term used to describe the physical operation of a gas or vapor adhering to a solid substance.

IDEAS ON SPECIFICATIONS, by Herbert L. Whittemore, M.E., Columbia Graphs, 128 pages, \$3.00. This book gives the results of nearly 30 years' experience in the preparation of Federal and other specifications, the inspection and testing of commodities for compliance, and advising Federal Departments on their procurement activities. It puts the engineer and specification writer in

possession of a store of accurate and authoritative information.

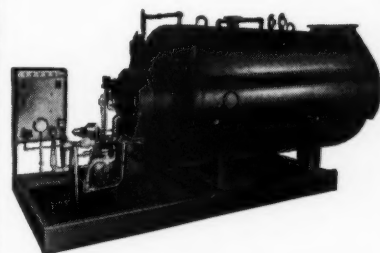
MINERAL WOOL INSULATION SPECIFICATIONS & STANDARDS, Industrial Mineral Fiber Institute Inc., \$3.50. This handbook is designed to guide buyers, engineers, plant superintendents, specification writers, and contractors in properly selecting materials and application practices for government contracts and as a basis for insulation specification within industry itself.

EQUIVALENT VALVES, Rev. Ed., Equivalent Valves Co., 170 pages, \$19.75. This loose-leaf manual compares valves of 20 leading manufacturers by material, type, size, pressure rating, and structural variations. Revision sets will be furnished to present manual holders for \$10.00.

REALISTIC DEPRECIATION POLICY, A Summary, Machinery & Allied Products Institute, 43 pages, \$1.00. This is a summary of findings resulting from an extensive study of depreciation policy by the Machinery and Allied Products Institute. The Institute concludes that American business is currently understating its consumption of capital by about \$7 billion annually. This is the result of inadequate charges to depreciation accounts. To correct this understatement of depreciation cost, the Institute recommends that taxpayers be permitted to adopt a double-rate declining balance write-off, with either group or item accounting, as an optional alternative to present methods.

PAY ALMANAC, 1954, by William J. Casey, J. K. Lasser and Walter Lord; Business Reports, Inc.; 166 pages, \$12.50. This survey covers the major problems and opportunities in rank and file and management pay during 1954. A considerable portion of the book presents comparative data designed to help management set intelligent pay policies for executive, office, and production groups. The Almanac surveys and tabulates pay rates and vacation allowances by job, by industry, and by locality. It highlights the difficulties faced by management in planning pay for middle income employees in 1954, and discusses the methods being used by many firms.

INDUSTRIAL INORGANIC ANALYSIS, by Roland S. Young, John Wiley & Sons, 388 pages, \$5.75. Written for chemists in the mining and metallurgical field as well as those in inorganic chemical industries, this book brings together notes based on Dr. Young's own experience. There are chapters on cyanogen, boron, calcium, carbon, chlorine, fluorine, nitrogen, oxygen, phosphorus, silicon, and sulphur. The author is with the International Nickel Company of Canada, Ltd.



"PACKAGED" STEAM BOILERS.

Completely Equipped and Tested at factory.

Fully Automatic for Gas or Heavy Oil or Combination Oil and Gas.

60 to 600 Horsepower. High and Low pressure. A.S.M.E. Code and Nat'l Board.

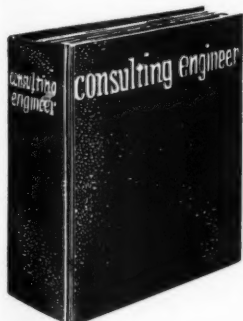
Efficiency and Capacity guaranteed.

Underwriter's Laboratory and Factory Mutual approved.

Detailed Specification Forms, Catalog, and other Engineering Data gladly furnished.

JOHNSTON BROTHERS, INC.
FERRYSBURG, MICHIGAN
Established 1864

Permanent Binders



\$3.00

Holds 12
copies of
CONSULTING
ENGINEER

Keep your copies of CE easily available in an attractive, permanent binder. Suitable for home or office library. Binder holds 12 copies, each fixed in place with a wire fastener. No punching or special binding equipment is required. These binders have CONSULTING ENGINEER stamped in gold on the front cover and on the spine.

Copies of most 1953 issues still available to complete your file.

CONSULTING ENGINEER
420 Main St. St. Joseph, Mich.

FEBRUARY 1954

Speed up
► BUYING
► RESEARCH
► PRODUCTION

GET INTO
THE
MASTER
HABIT!

**RADIO'S
MASTER**

**NEW! 1954
EDITION**

- 1370 pages
- Over 85,000 items
- Over 8,000 illus.
- Completely indexed

\$1.95 at your parts distributor
Publisher's price \$6.50

Make component buying simple and ease the problem of product specification. Have complete access to the many thousands of items vital to electronic research, design and production. You'll find them all in the Master with thoroughly complete descriptions, specs, illustrations and prices . . . all systematically organized in 18 big sections for instant reference. For jiffy comparison of products . . . use the Master, the only Official Buying Guide for the TV-Radio-Electronics industry. It contains unabridged catalog data direct from the manufacturers. The Master gives you all the needed facts in a single volume.

Over 100,000 in active daily use. Get into the Master habit. Order your copy today!

Just a few of the products included: Tubes — Test Equipment — Tools — Transformers — Capacitors — Resistors — Relays — Coils — Antennas — Recording & PA Systems — Hardware — Transmitters — Receivers — Kits — Wire — Cable . . . and thousands of allied products!



Eliminate
Incomplete
Small
Catalogs and
Loose
Literature

UNITED CATALOG PUB., INC.
110 LAFAYETTE ST., NEW YORK 13, N. Y.

ADVERTISERS' INDEX

Aluminum Company of America	8-9
Anaconda Wire & Cable Company	48
Automatic Control Company	7
•	
Babcock & Wilcox Company, The	3
Bayley Blower Company	75
Belco Industrial Equipment Division, Inc.	76
Bigelow-Liptak Corporation	73
Blackmer Pump Company	72
Bonney Forge & Tool Works	67
Bros Boiler & Manufacturing Company, Wm.	69
•	
Chicago & Eastern Illinois Railway	63
Cochrane Corporation	16
Coffin, Jr., Company, The	11
Combustion Engineering, Inc.	56
•	
Dampney Company, The	71
Diamond Power Specialty Corporation	10
•	
Federal Electric Products Company	15
Flexitallic Gasket Company	61
•	
General Cable Corporation	59
•	
Hays Corporation, The	Second Cover
Heacon, Inc.	65
•	
I-T-E Circuit Breaker Company	12-13, 54-55
•	
Johnston Brothers, Inc.	83
•	
Keckley Company, O. C.	68
Kellogg Company, M. W.	Fourth Cover
Kirkland Company, H. R.	14
•	
Neff & Fry Company	74
New York State Department of Commerce	64
Niagara Blower Company	80
•	
Patterson-Kelley Company, Inc.	79
Penberthy Injector Company	74
Permutit Company, The	Third Cover
Pick Manufacturing Company	62
•	
Reliance Gauge Column Company, The	78
Robertson Company, H. H.	70
•	
Thermix Corporation, The	4
Titusville Iron Works Company, Division of Struthers Wells Corporation	77
Tube Turns, Inc.	51-52
•	
United Catalog Publishers, Inc.	83
U. S. Steel Corporation	19

Sales Representatives

New York City, N. Y.

Theodore E. Gordon
11 West 42nd Street
Oxford 5-1495

Newark, New Jersey

C. Lester Seaman
10 Commerce Court
Market 3-0560

Philadelphia, Pennsylvania

David L. McKechnie
816 Lancaster Avenue
Villanova, Pennsylvania
Bryn Mawr 5-4692

Cleveland, Ohio

O. DeWitt Young
3304 Avalon Road
Shaker Heights, Ohio
Wyoming 1-4841

Chicago, Illinois

John D. Murray
360 N. Michigan, Rm. 614
Dearborn 2-3519

Los Angeles, California

Justin Hannon
4068 Crenshaw Boulevard
Axminister 2-9501